Upper Owyhee Watershed Subbasin Assessment and Total Maximum Daily Load Owyhee County, Idaho

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Abbreviations, Acronyms, and Symbols

303(d) Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section

§ Section (usually a section of federal or state rules or statutes)

Ag Plan Agricultural Pollution Abatement Plan

BIA Bureau of Indian Affairs

BLM United States Bureau of Land Management

BMP best management practice

BURP Beneficial Use Reconnaissance Program

C Celsius

CFR Code of Federal Regulations (refers to citations in the federal administrative rules)

cfs cubic feet per second

CWA Clean Water Act

CWAL Cold water aquatic life

DEQ Department of Environmental Quality

DO dissolved oxygen

EPA Environmental Protection Agency

F Fahrenheit

GIS Geographical Information Systems

HUC Hydrologic Unit Code

IDA Department of Agriculture

IDAPA Refers to citations of Idaho administrative rules

IDFG Idaho Department of Fish and Game

IDWR Department of Water Resources

km kilometer

km^2 square kilometer

LA load allocation

load capacity load capacity

m meter

m^2 square meter

MBI macroinvertebrate biotic index

mg/l milligrams per liter

mm millimeter

MOS margin of safety

NB natural background

ND no data (data not available)

NPDES National Pollutant Discharge Elimination System

NRCS Natural Resources Conservation Service

NTU nephelometric turbidity unit

ORMP Owyhee Resource Management Plan

PCR primary contact recreation

SBA subbasin assessment

SCR secondary contact recreation

SCC Soil Conservation Commission

SCD Soil Conservation District

SSShade Stream Segment Shade

SSTemp Stream Segment Temperature

STATSGO State Soil Geographic Database

TMDL total maximum daily load

USC United States Code

USDA United States Department of Agriculture

USGS United States Geological Survey

WAG Watershed Advisory Group

WLA wasteload allocation

YOY Young of the year

Executive Summary

The federal Clean Water Act requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to section 303 of the Clean Water Act are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the Clean Water Act establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop a total maximum daily load for the pollutants, set at a level to achieve water quality standards. This document addresses the water bodies in the Upper Owyhee Watershed Subbasin that have been placed on what is known as the "§303(d) list."

This subbasin assessment and total maximum daily load analysis has been developed to comply with Idaho's total maximum daily load schedule. This assessment describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Upper Owyhee Watershed Subbasin located in southwest Idaho. The first part of this document, the subbasin assessment, is an important first step in leading to the total maximum daily load. The starting point for this assessment was Idaho's current §303(d) list of water quality limited water bodies. Nine segments of the Upper Owyhee Watershed Subbasin were listed on this list. The subbasin assessment portion of this document examines the current status of §303(d) listed waters, and defines the extent of impairment and causes of water quality limitation throughout the subbasin. The loading analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

Subbasin at a Glance

Upper Owyhee River Subbasin	
HUC#:	17050104
SWB#:	230
Streams:	Red Canyon Cr., Nickel Cr., Deep Cr., Pole Cr., Battle Cr., Castle Cr., Shoofly Cr.
Reservoirs:	Juniper Basin, Blue Creek
Pollution Sources:	Nonpoint Sources
Ecoregion:	Snake River-High Desert
Size (Total):	1,384,288 Acres
Size (Idaho):	1,012,411 Acres

Figure A. Vicinity Map

The Upper Owyhee Subbasin, hydrologic unit code 17050104, encompasses a large area in southwest Idaho. The headwaters for the Owyhee River (East Fork) originate in northeast Nevada in the Independence Mountains. The watershed size is 1,384,288 acres total, with 1,012,411 acres within the state of Idaho and the Shoshone-Paiute Duck Valley Indian Reservation.

Within the Idaho portion of the watershed, there are nine water quality limited segments that were placed on the Idaho 1998 §303(d) list. Two segments are reservoirs, Juniper Basin and Blue Creek Reservoirs. One segment that was listed on the Idaho 1994 §303(d) list (Blue Creek) was removed from the list in 1998.

Listed pollutants of concern are sediment, bacteria, flow alteration and temperature. In accordance with the Beneficial Use Reconnaissance Program's Stream Macroinvertebrate Index scores and water quality samples, impaired beneficial uses included cold water aquatic life and primary contact recreation. Those water bodies determined to be not fully supporting their designated or existing beneficial uses and not meeting applicable water quality standards are required to have a total maximum daily load developed.

Figure B shows the Idaho 1998 §303(d) listed segments in the Upper Owyhee Watershed. Table A details each listed segments, impaired uses and pollutant(s) of concern.

Through the Upper Owyhee Watershed subbasin assessment process it was determined that most streams on the Idaho 1998 §303(d) list in the Upper Owyhee Watershed have cold water aquatic life and salmonid spawning as existing uses. In some cases, data show these uses are not supported due to exceedences of the state of Idaho Water Quality Standard temperature criteria.

In other cases, biological information showed impairment to cold water aquatic life and salmonid spawning. For those streams listed as not supporting primary and secondary contact recreation due to the presence of bacteria, monitoring has indicated those streams are full support.

A total maximum daily load has been developed for each stream determined to be not fully supporting beneficial uses in accordance with state of Idaho water quality standards. The total maximum daily loads address temperature reductions required to meet state of Idaho water quality standard criteria and/or in-stream sediment goals to maintain or restore cold water aquatic life and salmonid spawning. The total maximum daily loads use management objectives dealing with riparian conditions to obtain these goals.

Each segment will be addressed separately in this executive summary. Table B shows a breakdown of the findings in the subbasin assessment and actions to be taken (i.e., de-list, list or develop total maximum daily load).

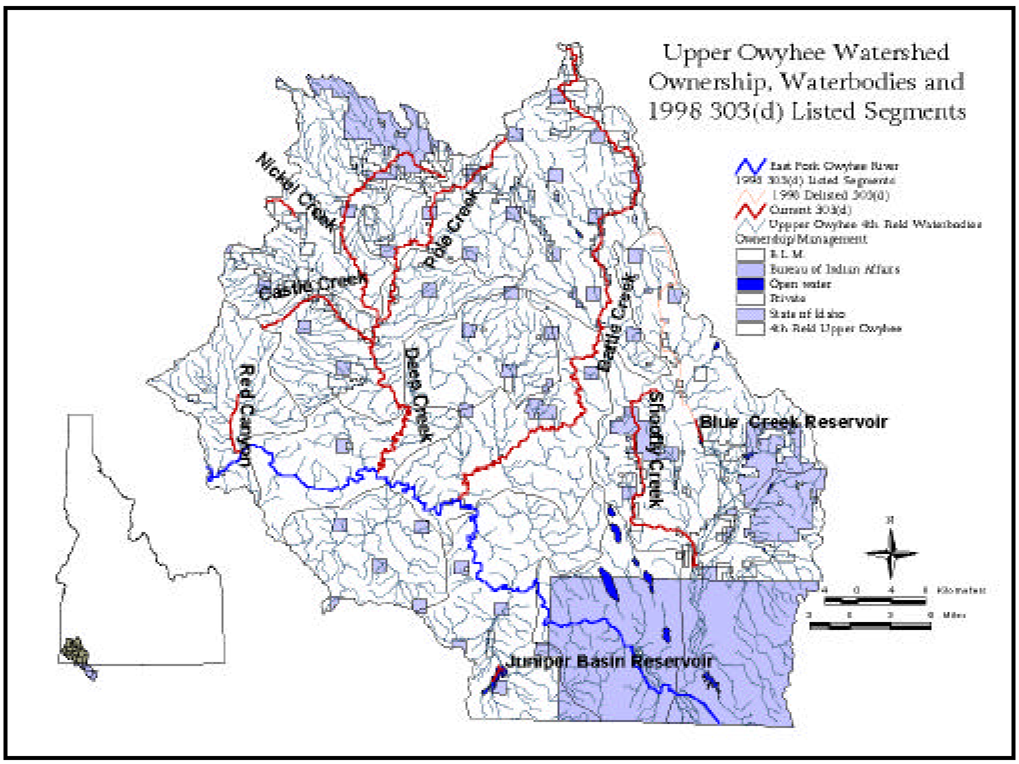


Figure B. Upper Owyhee Watershed Ownership, Water Bodies and the Idaho 1998 §303(d) Listed Segments.

Table A. Upper Owyhee Watershed 1998 §303(d) listed Segments, Descriptions, Listed Pollutants, Impaired Existing Uses, 5th Field HUCs and Miles (or Acres) of Streams Impaired.

Idaho 1998 §303(d) listed Segment	Description	Idaho 1998 §303(d) listed Pollutant(s)	Impaired Uses	5th Field HUC (s)	Idaho 1998 §303(d) listed Miles or Acres Impaired
Blue Creek Reservoir	Reservoir	Sediment	Cold Water Aquatic Life and Salmonid Spawning	Blue Creek Reservoir	185 acres
Juniper Basin Reservoir	Reservoir	Sediment	Cold Water Aquatic Life and Salmonid Spawning	Yatahoney	750 acres
Deep Creek	Mud Flat Road to Confluence with EF Owyhee	Sediment and Temperature	Cold Water Aquatic Life and Salmonid Spawning	Hurry Back, Deep Creek, Dickshooter, Pole Creek and Lower Owyhee	35 miles
Pole Creek	Headwaters to Confluence with Deep Creek	Sediment, Temperature, and Flow	Cold Water Aquatic Life and Salmonid Spawning	Pole Creek	24.1 miles
Castle Creek	Headwaters to Confluence with Deep Creek	Sediment and Temperature	Cold Water Aquatic Life and Salmonid Spawning	Deep Creek	11.3 miles
Battle Creek	Headwaters to Confluence with EF Owyhee	Bacteria	Primary and Secondary Contact Recreation	Upper Battle Creek and Lower Battle Creek	62.5 miles
Shoofly Creek	Headwaters to Confluence with Blue Creek	Bacteria	Primary and Secondary Contact Recreation	Blue Creek Reservoir	22.9 miles
Red Canyon Creek	Headwaters to Confluence with EF Owyhee	Sediment, Temperature, and Flow	Cold Water Aquatic Life and Salmonid Spawning	Red Canyon	5.2 miles
Nickel Creek	Headwaters to Mud Flat Road	Sediment	Cold Water Aquatic Life and Salmonid Spawning	Hurry Back	2.8 miles

There are no known point source discharges on any of the Idaho 1998 §303(d) listed segments. Any activity to address the goals and targets of the total maximum daily load will need to be undertaken through the use of best management practices on the current land uses. The goal of the total maximum daily loads is to achieve state of Idaho water quality standards for temperature and sediment, and to restore and maintain a healthy and balanced biological community for the full support of cold water aquatic life and salmonid spawning. The load allocations and targets will consist of heat reductions for temperature and sediment allocations based on land use. Surrogate measures of total shade and substrate targets will be presented to assist in achieving the load allocations.

Table B. Upper Owyhee Watershed 1998 §303(d) listed Segments and Recommended Actions.

Water Body	Pollutant(s)	TMDL(s) Completed	Recommended Changes to 1998 §303(d) list	Proposed Future Listing- Pollutant of Concern	Justification
Blue Creek Reservoir	Sediment	Yes Sediment	None	None	None
Juniper Basin Reservoir	Sediment	Yes Sediment	None	None	None
Deep Creek	Sediment and Temperature	Yes Sediment and Temperature	List Dissolved Oxygen as Pollutant of Concern	None	None
Pole Creek	Sediment, Temperature and Flow[1]	Yes Temperature	De-List Sediment as a Pollutant of Concern	None	None
Castle Creek	Sediment and Temperature	Yes Sediment and Temperature	None	None	None
Battle Creek	Bacteria	No	De-List Bacteria as a Pollutant of Concern, List Temperature as a Pollutant of Concern	Temperature	BLM[2] Temperature Data Indicated Exceedence of Temperature Criteria
Shoofly Creek	Bacteria	No	De-List Bacteria as a Pollutant of Concern	None	None
Red Canyon Creek	Sediment, Temperature and Flow	Yes Temperature	De-List Sediment as a Pollutant of Concern	None	None
Nickel Creek	Sediment	Yes Sediment	List Temperature Organic Enrichment and Metals as Pollutants of Concern	None	Idaho DEQ Temperature Data Indicated Exceedence of Temperature Criteria

1 No TMDL for Flow per Idaho DEQ policy, 2 Bureau of Land Management

Key Findings

Blue Creek Reservoir

1998 §303(d) listed:	Reservoir, 185 acres
Size:	Blue Creek Reservoir 5th Field HUC 136,477 acres
Impaired Existing Uses:	Cold Water Aquatic Life
Pollutant of Concern:	Sediment
TMDL Goal:	In-Reservoir Turbidity Levels to Provide Full Support for Cold Water Aquatic Life
TMDL Reduction Required:	Reduction in Turbidity Levels and Sediment Loads from Upstream Sources
Identified Sources:	Rangeland, Streambanks and Overland Erosion

Blue Creek Reservoir is a small in-stream impoundment located on Blue Creek in the Blue Creek Reservoir 5th Field HUC. The reservoir is approximately 185 acres in size and has a storage capacity of 250 acre/feet. The primary water use is irrigation water storage. In 2000, the Idaho Department of Fish and Game introduced domestic Kamloops trout in the reservoir. With the stocking of the Kamloops, the reservoir has been determined to have cold water aquatic life as an existing use and criteria to support this existing use therefore applies.

The listed pollutant of concern is sediment. Biological monitoring conducted in 2001 indicated sediment is impairing the biological communities. Thus, a total maximum daily load has been developed to address turbidity levels and an in-reservoir target of 25 nephelometric turbidity units has been established to obtain full support of cold water aquatic life. All other beneficial uses appear to be fully supported, including primary contact recreation. No other data was presented to indicate water supply, wildlife habitat or aesthetics beneficial uses are not fully supported.

Juniper Basin Reservoir

1998 §303(d) listed:	Reservoir, 749 acres
Size:	Yatahoney 5th Field HUC 107,994 acres
Presumed Existing Uses:	Cold Water Aquatic Life
Pollutant of Concern:	Sediment
TMDL Goal:	In-Reservoir Turbidity Levels to Provide Full Support for Cold Water Aquatic Life
TMDL Reduction Required:	Reduction in Turbidity Levels and sediment Loads from Upstream Sources
Identified Sources:	Rangelands, Streambanks and Overland Erosion

Juniper Basin Reservoir is a shallow low-lying reservoir located on the desert plateaus west of the Shoshone-Paiute Duck Valley Reservation, and directly north of the state line of Idaho and Nevada. Portions of the reservoir's watershed originate in Nevada. The primary purpose of the reservoir, at one time, was irrigation water storage. However, the irrigation water delivery system has been in disrepair for a long period of time and is no longer operable.

No data were found to determine if aquatic life is an existing use, nor were any data provided to justify the reservoir being placed on the Idaho 1998 §303(d) list. *The Idaho Water Quality Nonpoint Source Assessment* assessed the reservoir as all beneficial uses, except warm water aquatic life, as supported but threatened. However, the assessments were made based on best professional judgement with no data presented to justify the support status of the beneficial uses.

The Idaho Department of Fish and Game's *Fisheries Management Plan* for the Owyhee River has the area around Juniper Basin Reservoir listed for mixed fisheries management. However, it is still not known what the existing aquatic uses are for the reservoir.

Biological monitoring conducted in 2001 indicated sediment is impairing the biological communities. Since it is presumed that Juniper Basin Reservoir can support cold water aquatic life and without information available to determine the status of existing aquatic use, a total maximum daily load has been developed to address turbidity levels in the reservoir. The total maximum daily load is written to address in-reservoir turbidity levels and upstream sediment sources.

Deep Creek

1998 §303(d) listed:	3rd, 4th and 5th Order Stream, 46 miles
Size:	Hurry Back, Deep Creek, Dickshooter, Lower Owyhee, and Pole Creek 5th Field HUCs 255,393 Total Acres
Impaired Existing Uses:	Cold Water Aquatic Life and Salmonid Spawning
Pollutants of Concern:	Sediment and Temperature
TMDL Goals:	Sediment: In Stream Substrate Percent Fines (<6 mm) of 30% or Less, Streambank Erosion Rates and Sediment Load Allocation Temperature: Achieve State Water Quality Standards for the Full Support of Salmonid Spawning Through Reduced Solar Radiation
Identified Sources:	Streambank Conditions, Overland Erosion and Solar Radiation

Deep Creek is the largest subwatershed in the Upper Owyhee Watershed and covers one quarter million acres of mostly federal and state managed lands. Deep Creek is a 5th order stream at its confluence with the East Fork Owyhee River. The stream flows through mostly incised canyons in the lower sections of the Y-P Desert. The stream gradient is usually less than 2%. The creek has many long sections of shallow glides broken by short sections of riffles. Large sections of cobble-gravel bars are present throughout most of the lower sections, with sand and pea gravel in the upper section's substrate.

Past Beneficial Use Reconnaissance Program Macroinvertebrate Biotic Index scores were varied. Some scores indicated cold water aquatic life was fully supported, while others indicated not fully supported or needs verification. With mixed information on the status of cold water aquatic life support, Deep Creek remained on the Idaho 1998 §303(d) list. The Idaho Department of Fish and Game's *Fisheries Management Plan* for the Owyhee River has Deep Creek listed for the management of wild redband trout.

To determine if sediment is impairing cold water aquatic life, the biological indicator communities of macroinvertebrates and periphyton were examined. Periphyton analyses showed that some sections of Deep Creek are severely impaired by sediment, while others are not. Some periphyton data indicated organic enrichment is a minor impairment during certain periods of the late spring and summer.

Macroinvertebrate data analyses showed that many of the samples collected had Plecoptera species that were mostly moderately tolerant of fine sediment. No species were found that were intolerant of fine sediment. These data indicates sediment is impairing the cold water aquatic life in Deep Creek. Since these samples represented two variations in the stream's hydrograph, it is concluded that sediment is impairing cold water aquatic life throughout the summer, and this includes sediment both in the water column and as bedload.

A sediment load allocation has been written for Deep Creek based on suspended sediment criteria established in other total maximum daily loads to maintain or restore existing uses. Also, an in-stream goal of percent fines (<6 mm) of 30% or less for the substrate and streambank erosion rates for Deep Creek will be established.

Water temperature data from June 1 through September 30, 2000 and 2001, indicated the state of Idaho water quality criteria for the protection of cold water aquatic life and salmonid spawning are exceeded on almost every date that temperature data are available. The Stream Segment Temperature Model was used to calculate heat reduction required to achieve state of Idaho water quality standards. Through the use of Stream Segment Temperature Model, it was calculated that the shading of the stream would have to be between 80 and 100%. This value is also for all streams within the Deep Creek Watershed. Calculations also showed that if the temperature criteria are not met on tributary segments within the watershed, the temperature target would not be met in Deep Creek as well for the month of June.

Pole Creek

1998 §303(d) listed:	3rd Order Stream, 24 miles
Size:	Pole Creek 5th Field HUC 54,550 Total Acres
Impaired Existing Uses:	Cold Water Aquatic Life and Salmonid Spawning
Pollutants of Concern:	Sediment, Temperature, and Flow Alteration
TMDL Goal:	Temperature: Achieve State Water Quality Standards for the Full Support of Salmonid Spawning Through Reduced Solar Radiation
Identified Source:	Solar Radiation

Past Beneficial Use Reconnaissance Program information showed mixed results when used to determine cold water aquatic life support status. The Idaho Department of Fish and Game's *Fisheries Management Plan* for the Owyhee River has Pole Creek (a tributary of Deep Creek) listed for management of wild redband trout.

To determine if sediment were impairing cold water aquatic life, periphyton samples were examined to determine if the biological indicators are affected. Periphyton analysis showed that there was no indication that sediment is impairing cold water aquatic life. Thus, no total maximum daily load will be developed for sediment. Sediment should be removed as a pollutant of concern for Pole Creek.

Water temperature data from June 1 through September 30, 2000 and 2001, indicate the state of Idaho water quality criteria for the protection of cold water aquatic life are exceeded between 44-86% of all dates sampled. For salmonid spawning, 100% of all dates sampled June 1 through July 1 exceeded the criteria. Through the use of Stream Segment Temperature Model, it was calculated that the shading of the stream would have to be between 80-100%. This value is also for all streams within the Pole Creek Watershed. Calculations showed if the temperature criteria is not met on tributary segments within the watershed, the temperature targets will not be met in Pole Creek in the month of June.

Castle Creek

1998 §303(d) listed:	3rd Order Stream, 11.5 miles
Size:	Deep Creek 5th Field HUCs 71,598 Total Acres
Impaired Existing Uses:	Cold Water Aquatic Life and Salmonid Spawning
Pollutants of Concern:	Sediment and Temperature
TMDL Goal:	Sediment: In Stream Substrate Percent Fines (<6 mm) of 30% or Less, Streambank Erosion Rates and Sediment Load Allocation Temperature: Achieve State Water Quality Standards for the Full Support of Salmonid Spawning through Reduced Solar Radiation
Identified Sources:	Streambank Conditions, Overland Erosion and Solar Radiation

Past Beneficial Use Reconnaissance Program data indicated cold water aquatic life was not fully supported. The Idaho Department of Fish and Game's *Fisheries Management Plan* for the Owyhee River has Castle Creek (a tributary of Deep Creek) listed for management of wild redband trout.

To determine if sediment is impairing cold water aquatic life, the biological communities of macroinvertebrates and periphyton were examined. Periphyton analyses showed that some sections of Castle Creek are moderately impaired by sediment. Also, some periphyton data indicated organic enrichment is also a minor impairment during certain periods of the late spring and summer.

Macroinvertebrate data analyses showed that many of the samples collected had Plecoptera species that were mostly moderately tolerant of fine sediment. No species were found that were intolerant of fine sediment. These data indicate sediment is impairing the cold water aquatic life in Castle Creek. Since the samples represented two variations in the stream's hydrograph, it is concluded that sediment is impairing cold water aquatic life throughout the summer, and both this includes water column and bedload sediment.

A sediment load allocation has been written for Castle Creek based on suspended sediment criteria established for other total maximum daily loads to maintain or restore existing uses.

Also, an in-stream goal of percent fines (<6 mm) of 30% or less for the substrate and streambank erosion rates for Deep Creek will be established.

Water temperature data from June 23 through August 24, 2000 and 2001, indicated the state of Idaho water quality criteria for the protection of cold water aquatic life are exceeded 81-100% of all dates sampled. For salmonid spawning, 100% of all dates sampled June 23 through July 1 exceeded the criteria. Through the use of Stream Segment Temperature Model it was calculated that the shading of the stream would have to be between 80-100%.

Battle Creek

1998 §303(d) listed:	1st, 2nd, 3^{rd,} 4th, 5th Order Stream, 62.5 miles
Size:	Upper Battle Creek and Lower Battle Creek 5th Field HUCs 71,598 Total Acres
Impaired Existing Uses:	Primary and Secondary Contact Recreation
Pollutants of Concern:	Bacteria
TMDL Goal:	No TMDL Required
Recommendations:	Limited BLM Data has Indicated Water Temperature Exceeds Water Quality Standards for Cold Water Aquatic Life, List for Temperature on next 303(d) listing Cycle

Battle Creek was listed on the 1998 §303(d) list for the presence of bacteria. The listing was based on one sample out of many samples collected and analyzed for fecal coliform by the Bureau of Land Management. Follow-up monitoring used *E. coli* as the indicator to determine the support status. Results showed primary and secondary contact recreations are fully supported.

Temperature data provided by the Bureau of Land Management for summer 1999 and again in 2000 showed state water quality standards temperature criteria were exceeded. However, for both years the data was limited to a 45 day period. There is not enough information to develop a total maximum daily load at this time, but Battle Creek should be listed for temperature on the next listing cycle and placed on a schedule for subbasin assessment and total maximum daily load development at later date.

Shoofly Creek

1998 §303(d) listed:	1^{st}, 2^{nd}, 3^{rd} Order Stream, 22.85 miles
Size:	Blue Creek Reservoir 5^{th} Field HUCs 136,777 Total Acres
Impaired Existing Uses:	Primary and Secondary Contact Recreation
Pollutants of Concern:	Bacteria
TMDL Goal:	No TMDL Required
Recommendations:	De-List Bacteria as a Pollutant of Concern and Remove from 303(d) list

Shoofly Creek was listed on the 1998 §303(d) list for the presence of bacteria. The listing was based on one sample out of many samples collected and analyzed for fecal coliform. Follow-up monitoring conducted by the Department of Environmental Quality using *E. coli* as the indicator for the support status, determined primary and secondary contact recreation uses were fully supported.

Red Canyon Creek

1998 §303(d) listed:	3rd Order Stream, 5.1 miles
Size:	Red Canyon 5th Field HUCs 49,898 Total Acres
Impaired Existing Uses:	Cold Water Aquatic Life and Salmonid Spawning
Pollutants of Concern:	Sediment, Temperature and Flow Alteration
TMDL Goal:	Temperature: Achieve State Water Quality Standards for the Full Support of Salmonid Spawning Through Reduced Solar Radiation
Identified Sources:	Solar Radiation

Past Beneficial Use Reconnaissance Program data indicated cold water aquatic life was fully supported. The Idaho Department of Fish and Game's *Fisheries Management Plan* for the Owyhee River lists Red Canyon Creek as managed for a mixed fishery (seasonal cold). However, data collected in 1995 showed a diverse age class of redband trout exists in Red Canyon Creek. Thus, salmonid spawning is an existing use and the state of Idaho water quality standards and criteria are applicable to protect the existing use. Red Canyon Creek is designated in the state of Idaho water quality standards for cold water aquatic life and primary contact recreation.

Water temperature data collected from June 23 through July 1, 2000 and 2001 show that the criteria for the support of salmonid spawning was exceeded on all sampled dates. Through the use of Stream Segment Temperature Model it was calculated that the shading of the stream would have to be between 80 and 100%. This value is also for all streams within the Red Canyon Creek Watershed. Calculations showed if the temperature criteria is not met on tributary segments within the watershed, the temperature targets will not be met in Red Canyon Creek.

To determine if sediment was impairing cold water aquatic life, periphyton samples were examined. Periphyton analyses showed that there was no indication that sediment is impairing cold water aquatic life. Thus, no total maximum daily load will be developed for sediment. Sediment should be removed as a pollutant of concern for Red Canyon Creek.

Nickel Creek

1998 §303(d) listed:	3rd Order Stream, 2.7 miles
Size:	Hurry Back 5th Field HUCs 98,405 Total Acres
Impaired Existing Uses:	Cold Water Aquatic Life and Salmonid Spawning
Pollutant of Concern:	Sediment
TMDL Goal:	Sediment: In Stream Substrate Percent Fines (<6 mm) of 30% or Less, Streambank Erosion Rates and Sediment Load Allocation
Identified Sources:	Streambank Conditions, Overland Erosion and Solar Radiation

Past Beneficial Use Reconnaissance Program data indicated cold water aquatic life was not fully supported. The Idaho Department of Fish and Game's *Fisheries Management Plan* for the Owyhee River has Nickel Creek (a tributary of Deep Creek) listed as managed for wild redband trout.

Macroinvertebrate data analyses showed that many of the samples collected had Plecoptera species that were moderately tolerant of fine sediment. No species were found that were intolerant of fine sediment. This data would indicate sediment is impairing the cold water aquatic life in Nickel Creek. Since the samples represented two variations in the stream's hydrograph, it is concluded that sediment is impairing cold water aquatic life throughout the summer, and this includes both water column sediment and bedload sediment. Periphyton analyses showed slight impairment of cold water aquatic life. However, there was no indication that sediment is the source of impairment. Analyses also showed there are possible chronic metal toxicity and organic enrichment.

A total maximum daily load for sediment has been developed to address the most likely source of sediment in Nickel Creek. The sediment load allocation has been written for Nickel Creek based on suspended sediment criteria established for other total maximum daily loads to maintain or restore existing uses. Also, an in-stream goal of percent fines (<6 mm) of 30% or less for the substrate and targeted streambank erosion rates for Nickel Creek was established.

Temperature monitoring was conducted on Nickel Creek for the possible use as a reference stream. Data indicated that Nickel Creek exceeds desired temperature criteria for the support of salmonid spawning. However the data set is limited to 22 days from June 23 to July 15, 2000. Considering that Nickel Creek is not listed on the 1998 §303(d) list for temperature and the lack of sufficient temperature data, it is recommend temperature be placed as a pollutant of concern on the next §303(d) list.

Proposed Listing on Next Idaho §303(d) List

During the development of the Upper Owyhee Watershed subbasin assessment, the Bureau of Land Management provided limited summer temperature data for Camas Creek and Camel Creek, which are tributaries to Pole Creek, and Battle Creek. The data indicated the temperature criteria for the support of cold water aquatic life is exceeded for these water bodies. The data were limited to a period that did not include the timeframe for salmonid spawning and incubation periods. It is recommended these water bodies be listed for temperature on the next Idaho §303(d) list with temperature as the pollutant of concern. Table B describes other suggested changes to the next §303(d) list.

Through the use of the criteria to determine the support status of beneficial uses as outlined in the *Water Body Assessment Guidance* two additional streams were found to be not fully supporting beneficial uses. These water bodies are Dry Creek and Beaver Creek. Table C shows water bodies that should be placed on the next cycle for the next §303(d) listing.

Table C. Additional Water Quality Limited Segments to be Listed as Water Quality Limited and/or Pollutants of Concern Placement on Next §303(d) List. Upper Owyhee Watershed.

Stream Name	Proposed Pollutant(s) of Concern	Impaired Beneficial Use(s)	Justification for Listing
Battle Creek	Temperature	Cold Water Aquatic Life and Salmonid Spawning	Temperature Data Provided by Bureau of Land Management
Nickel Creek	Temperature and Metals	Cold Water Aquatic Life and Salmonid Spawning	Data Presented in Subbasin Assessment
Camas Creek	Temperature	Cold Water Aquatic Life and Salmonid Spawning	Temperature Data Provided by Bureau of Land Management
Camel Creek	Temperature	Cold Water Aquatic Life and Salmonid Spawning	Temperature Data Provided by Bureau of Land Management
Dry Creek	Unknown	Cold Water Aquatic Life and Salmonid Spawning	As Per Water Body Assessment Guidance
Beaver Creek	Unknown	Cold Water Aquatic Life and Salmonid Spawning	As Per Water Body Assessment Guidance

Time Frame for Meeting Water Quality Standards

The development of an implementation plan can be completed in a timely manner. However, implementation of best management practices may take years and is dependent on available resources, funding and prioritization from land management agencies. A long-term monitoring plan will be developed to determine if the total maximum daily load needs to be refined and to assure goals and targets of the total maximum daily load are being achieved.

Studies have shown the improvement to stream morphology, riparian conditions, streambank stability and stream hyporheic conditions may take anywhere from 20 to 100 years. Medium term management goals such as stream canopy density trends and bank stabilizing vegetation targets could be met in five to ten years. Short term management goals such as changes in vegetation utilization and bank condition could be met in one or two years.

Some biological indicators may respond quickly to reduced sediment input and habitat improvement. Warm water intolerant species may take longer and may not re-establish until benefits from reduced solar radiation and increased ground water effectively cool the water.

Implementation Strategy

The implementation strategy addresses the cursory development of an implementation plan for the Upper Owyhee Watershed. State and federal agencies, which will assist in implementing best management practices to achieve the targets and goals are identified. These agencies are Bureau of Land Management, Idaho Department of Lands, Idaho Soil Conservation Commission and Idaho Department of Environmental Quality.

As with any implementation plan addressing non-point sources, an adaptive management approach will be a critical component of any plan developed for the watershed. As more data is collected, future modification to the load allocation may occur which include more accurate water body sediment loading and water body shading potential. Although not anticipated, possible regulatory strategies are in place and can be addressed through current regulatory authority.

Much of the implementation of best management practices will be dependent on the availability of funding and personnel resources. Current state and federal cost share programs will assist private landowners in addressing load allocations on private holdings. It is expected that the identified state and federal agencies will work closely with Idaho Department of Environmental Quality during all phases of best management practices implementation and best management practices effectiveness evaluation.

Monitoring of the goals and targets stated in the total maximum daily load need to be conducted to determine;

1) if the overall goal of achieving and maintaining compliance with state water quality standards are being meet,
2) if the implemented best management practices are working as designed or if modification need to occur,

3) if load allocations need to be adjusted, and
4) if best management practices are being implemented in a timely manner to address water quality concerns, and

Public Involvement

In December 2001, a presentation to the Southwest Idaho Basin Advisory Group was given to update the group on the development of the Upper Owyhee Watershed Subbasin Assessment and Total Maximum Daily Load. A final update was presented to the group in November 2002.

In August 2002, the document was sent to the Idaho Department of Environmental Quality State Office for administrative and technical review. The Upper Owyhee Watershed Subbasin Assessment and Total Maximum Daily Load document was submitted to the public for a comment period commencing on October 18, 2002 and ending November 22, 2002. However, comments received the week of November 25, 2002 were considered.

Two public meeting were conducted during the week of November 4, 2002. These meeting were held at the Owyhee County Courthouse in Murphy, Idaho and at the Pleasant Valley School located outside Jordan Valley, Oregon. Public notices were published in three local newspapers announcing the release of the document for public comment and location of public meetings.

Notification of the release of the document and the request for comments was sent to members of the North-Middle Fork Owyhee River Watershed Advisory Group and other interested groups/stakeholders. An impromptu meeting was conducted on November 26, 2002 at the Idaho Department of Environmental Quality Boise Regional Office to discuss issues with the document.

1. Subbasin Assessment – Watershed Characterization

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters (33 USC § 1251.101). States and tribes, pursuant to section 303 of the CWA are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses the water bodies in the Upper Owyhee Watershed that have been placed on what is known as the "§303(d) list."

The overall purpose of this SBA and TMDL is to characterize and document pollutant loads within the Upper Owyhee Watershed. The first portion of this document, the subbasin assessment (SBA), is partitioned into four major sections: watershed characterization, water quality concerns and existing beneficial uses status, pollutant source inventory, and a summary of past and present pollution control efforts (Chapters 1 – 4). This information will then be used to develop a TMDL for each pollutant of concern, if required, for the Upper Owyhee Watershed (Chapter 5).

1.1 Introduction

In 1972, Congress passed public law 92-500, the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Pollution Control Federation 1987). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed. The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "swimmable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

Background

The federal government, through the U.S. Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the county. The Idaho Department of Environmental Quality (DEQ) implements the CWA in Idaho, while the EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires Idaho DEQ to adopt, with EPA approval, water quality standards and to review those standards every three years. Additionally, Idaho DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, Idaho DEQ must establish TMDLs for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the water bodies to meet their designated uses. These requirements result in a list of impaired waters, the "§303(d) list." This list describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. A SBA and TMDL provide a summary of the water quality status and allowable TMDL for water bodies on the §303(d) list. The *Upper Owyhee Watershed Subbasin Assessment and Total Maximum Daily Load Owyhee County, Idaho* provides this summary for the currently listed waters in the Upper Owyhee Watershed.

The SBA section of this report (Chapters 1 – 4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the Upper Owyhee Watershed to date. While this assessment is not a requirement of the TMDL, Idaho DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (40 CFR § 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also includes individual pollutant allocations among various sources discharging the pollutant. The EPA considers certain unnatural conditions, such as flow alteration, a lack of flow, or habitat alteration, that are not the result of the discharge of specific pollutants as "pollution." TMDLs are not required for water bodies impaired by pollution, but not specific pollutants. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Idaho's Role

Idaho adopts water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

The state may assign or designate beneficial uses for particular Idaho water bodies to support. These beneficial uses are identified in the Idaho water quality standards and include:

- Aquatic life support – cold water, seasonal cold water, warm water, salmonid spawning, modified

- Contact recreation – primary (swimming), secondary (boating)

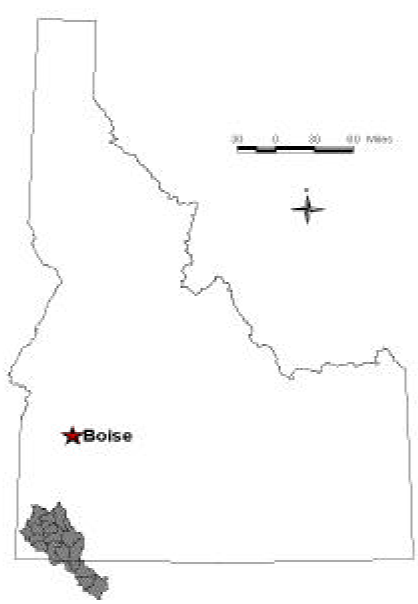
- Water supply – domestic, agricultural, industrial

- Wildlife habitats, aesthetics

The Idaho legislature designates uses for water bodies. Industrial water supply, wildlife habitat, and aesthetics are designated beneficial uses for all water bodies in the state. If a water body is unclassified, then cold water and primary contact recreation are used as additional default designated uses when water bodies are assessed.

A SBA entails analyzing and integrating multiple types of water body data, such as biological, physical/chemical, and landscape data to address several objectives:

- Determine the degree of designated beneficial use support of the water body (i.e., attaining or not attaining water quality standards).
- Determine the degree of achievement of biological integrity.
- Compile descriptive information about the water body, particularly the identity and location of pollutant sources.
- When water bodies are not attaining water quality standards, determine the causes and extent of the impairment.



Upper Owyhee River Subbasin	
HUC#:	17050104
SWB#:	230
Streams:	Red Canyon Cr., Nickel Cr., Deep Cr., Pole Cr., Battle Cr., Castle Cr., Shoofly Cr.
Reservoirs:	Juniper Basin, Blue Creek
Pollution Sources:	Nonpoint Sources
Ecoregion:	Snake River-High Desert
Size (Total):	1,384,288 Acres
Size (Idaho):	1,012,411 Acres

Figure 1. Subbasin at a Glance. Upper Owyhee Watershed

1.2 Watershed Characteristics

The Upper Owyhee Subbasin, hydrologic unit code (HUC) 17050104, encompasses a large area in southwest Idaho and northern Nevada (Figure 2). The headwaters for the Owyhee River (East Fork) originate in northeast Nevada and the Independence Mountains. The Wild Horse Reservoir is a collection site for 2nd and 3rd order streams in the headwaters. Impoundment releases from the reservoir are governed by irrigation water demand and flood control. The East Fork Owyhee River then flows northwest through an incised canyon. After entering the Shoshone Paiute Indian Reservation, the valley bottom type broadens out into an alluvial depositional area and irrigated agriculture dominates the land use. Irrigation water is diverted from the East Fork Owyhee River at China Dam, a small in-river diversion, with a majority of irrigation waters diverted to the Duck Valley or Agency Canals. Irrigation water is either diverted out of the canals or from the East Fork Owyhee River for irrigating pasture and hayfields on tribal or private lands. Remaining irrigation water in the Duck Valley Canal is stored in the Sheep Creek Reservoir, which then irrigates agricultural areas in the South Fork Owyhee River drainage. The South Fork Owyhee River, in Idaho, had a SBA and TMDL completed in 1999 (Idaho DEQ 1999*a*). The East Fork Owyhee River flows into the state of Idaho at approximately river mile 79.4 (based on river miles from the South Fork of the Owyhee River), near China Dam. The river remains on tribal lands for another 13 miles.

To date, the Shoshone-Paiute Tribe has not listed any water quality limited segments within its tribal lands. Furthermore, the state of Idaho has not listed any water quality limited segments within tribal boundaries.

One Idaho §303(d) listed stream, Shoofly Creek, flows into Blue Creek, which enters tribal lands near the north boundary of the Reservation. However, Blue Creek is not a water quality limited segment (Idaho DEQ 1998).

After the river leaves tribal lands, it flows mostly westerly through deep canyons and the plateaus of the Owyhee-YP Desert. This area of Idaho is sparsely populated with most lands managed by the United States Department of Interior, Bureau of Land Management (BLM). Land use is mainly open rangeland, with some irrigated land on private holdings.

Although the East Fork Owyhee River is not listed as a water quality limited segment, three tributaries are (Idaho DEQ 1998). The other remaining §303(d) listed water bodies are tributaries to those water bodies, reservoirs, or are streams that are hydrologically connected to the East Fork Owyhee River. Further evaluation of the East Fork Owyhee River will be required utilizing the *Water Body Assessment Guidance* (Idaho DEQ 2000*b*) and the *Idaho River Ecological Assessment Framework* (Idaho DEQ 2000*c*). This document will not attempt to assess interstate or tribal water quality concerns. However, sediment allocation for one segment will establish a sediment reduction from the state of Nevada.

The water quality limited segments within the Upper Owyhee River Watershed were listed on Idaho's 1998 §303(d) list in response to litigation in Federal District Court. This litigation effort was based on concerns for the 1994 §303(d) list (Idaho DEQ 1994) and the 1988 *Idaho Water Quality Status Report and Nonpoint Source Assessment* (Idaho DEQ 1988). Table 1 describes the listed water quality limited segments (§303(d) listed streams), pollutants of concern, miles of streams listed, and possible beneficial uses impaired (Idaho DEQ 1998). Figure 3 shows the Upper Owyhee Watershed and the §303(d) listed segments.

Table 1. Idaho §303(d) listed Streams (Idaho DEQ 1998). Upper Owyhee Watershed.

Stream	Pollutants of Concern	Stream Miles	Impaired Uses
Blue Creek Reservoir	Sediment	185 Acres	CWAL[a], SS[b]
Juniper Basin Reservoir	Sediment	750 Acres	CWAL, SS
Deep Creek	Sediment, Temperature	46.1	CWAL, SS
Pole Creek	Sediment, Temperature, Flow Alteration	24.0	CWAL, SS
Castle Creek	Sediment, Temperature	11.5	CWAL, SS
Battle Creek	Bacteria	62.3	PCR[c]
Shoofly Creek	Bacteria	22.9	PCR
Red Canyon Creek	Sediment, Temperature, Flow Alteration	5.2	CWAL, SS
Nickel Creek	Sediment	2.8	CWAL, SS

a. Cold Water Aquatic Life; b. Salmonid Spawning; c. Primary Contact Recreation

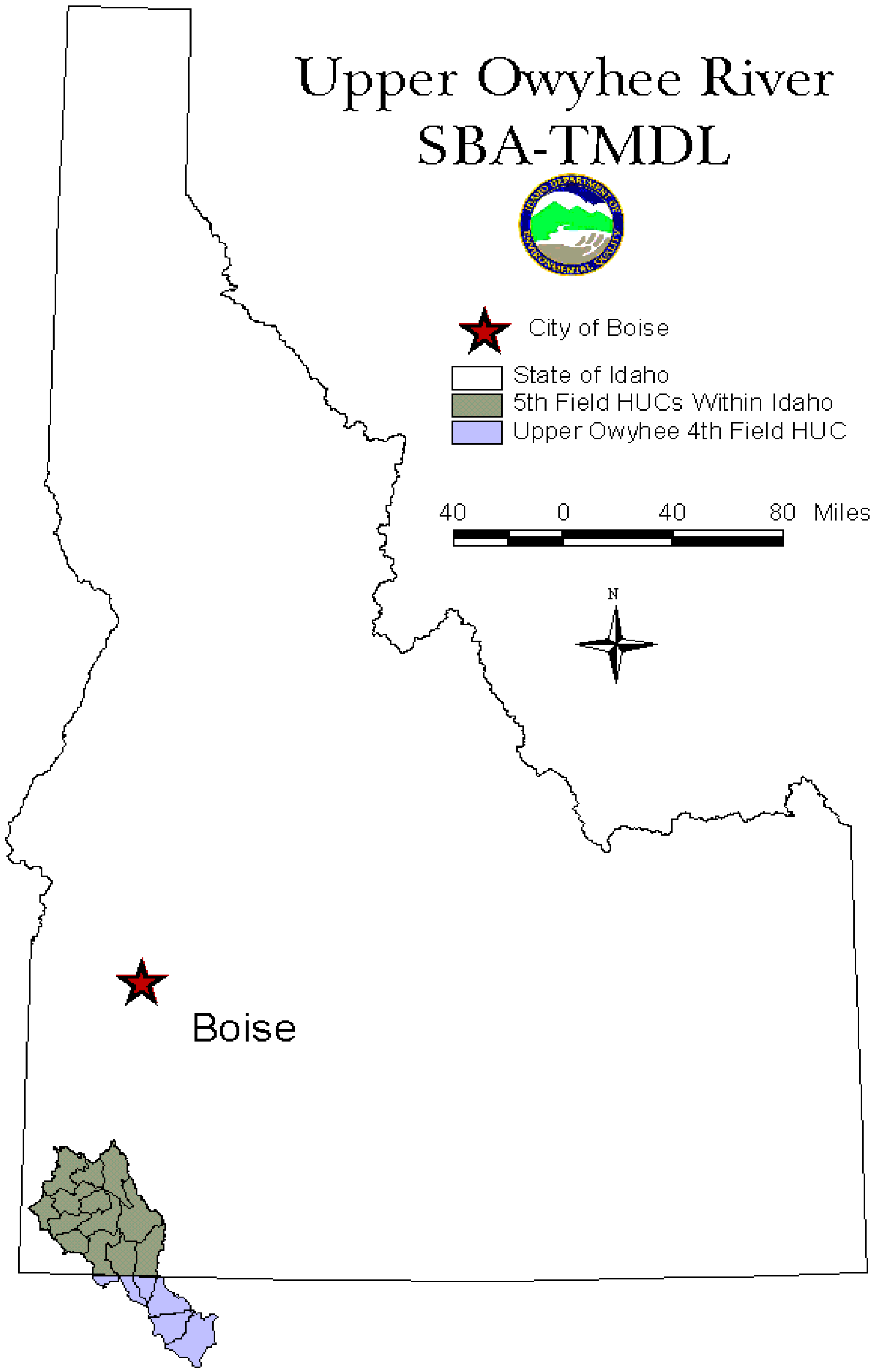


Figure 2. Upper Owyhee Watershed.

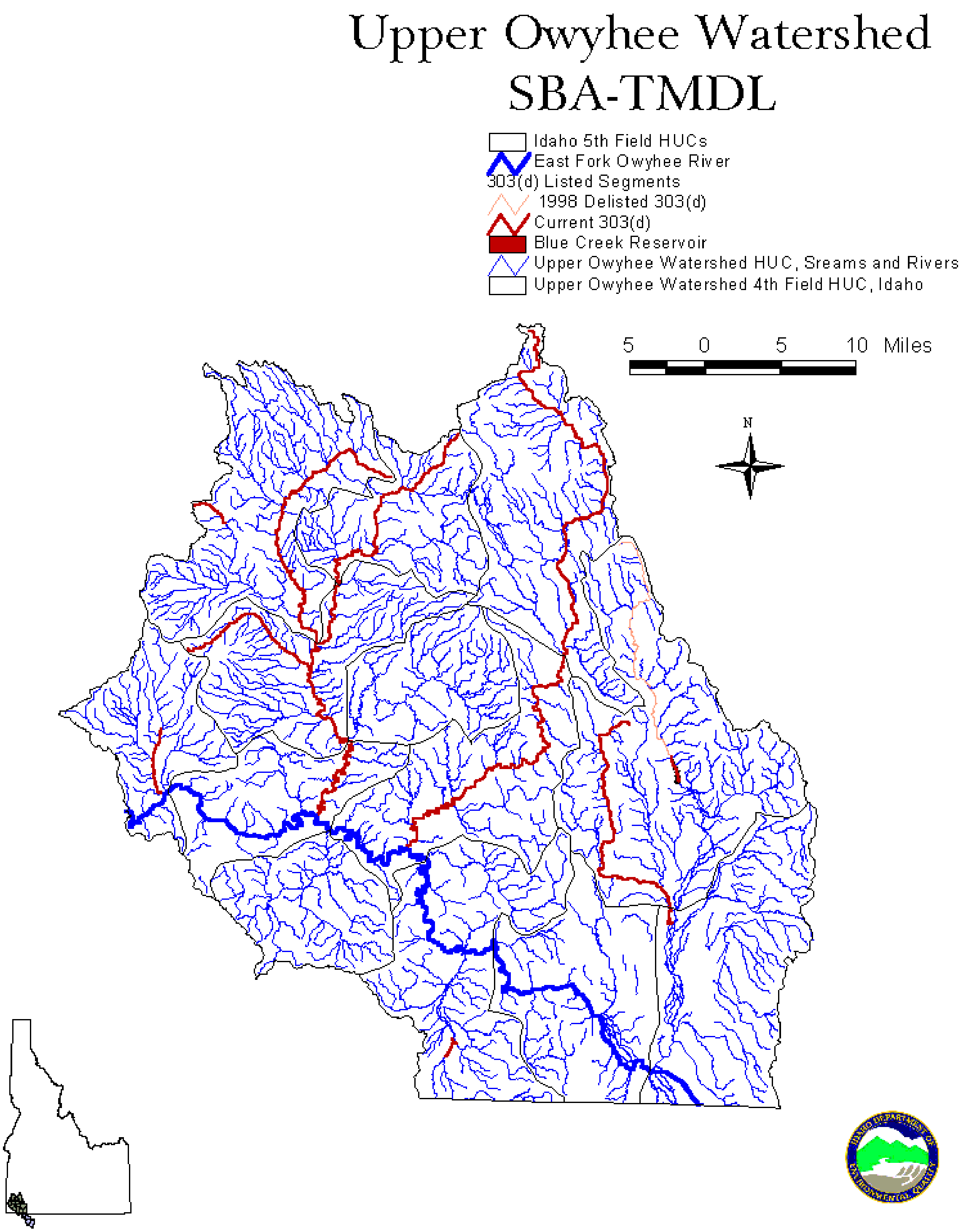


Figure 3. Streams, Rivers and §303(d) listed Segments. Upper Owyhee Watershed.

Fourth Field and Fifth Field HUCs

The upper Owyhee 4th field HUC spans two states, Idaho and Nevada, along with the Shoshone-Paiute Duck Valley Indian Reservation. Some related statistical data related to the entire Upper Owyhee Watershed 4th Field HUC is located in Appendix B. Table 2 describes the 5th field HUCs, with water quality limited segments that will be addressed in those HUCs, and drainage acres. Figure 4 shows 5th Field HUCs.

Table 2. 5th Field HUCs, Drainage Acres and Water Quality Limited §303(d) listed Segments. Upper Owyhee Watershed

5th Field HUC	State	§303(d) listed Segment	Drainage Acres
Upper Battle Creek	Idaho	Battle Creek	100,653
Hurry Back Creek	Idaho	Deep Creek, Nickel Creek	98,405
Pole Creek	Idaho	Pole Creek	54,550
Blue Creek Reservoir	Idaho	Blue Creek Reservoir, Shoofly Creek	136,477
Deep Creek	Idaho	Deep Creek, Castle Creek	71,598
Dickshooter Creek	Idaho	NA	49,010
Lower Battle Creek	Idaho	Battle Creek	82,525
Red Canyon	Idaho	Red Canyon Creek	49,898
Lower Owyhee River	Idaho	NA	53,428
Blue Creek	Idaho/Tribe	Shoofly Creek	129,460
Yatahoney Creek	Idaho/Tribe/Nev.	Juniper Basin Reservoir	107,994
Paiute Creek	Idaho	NA	50,634
Ross Lake	Idaho/Tribe/Nev.	NA	110,009
Middle Owyhee River	Tribe/Nevada	NA	84,058
Upper Owyhee River	Tribe/Nevada	NA	76,672
Wild Horse Reservoir	Tribe/Nevada	NA	128,917
		Total Acres (includes portions in Nevada)	1,384,288

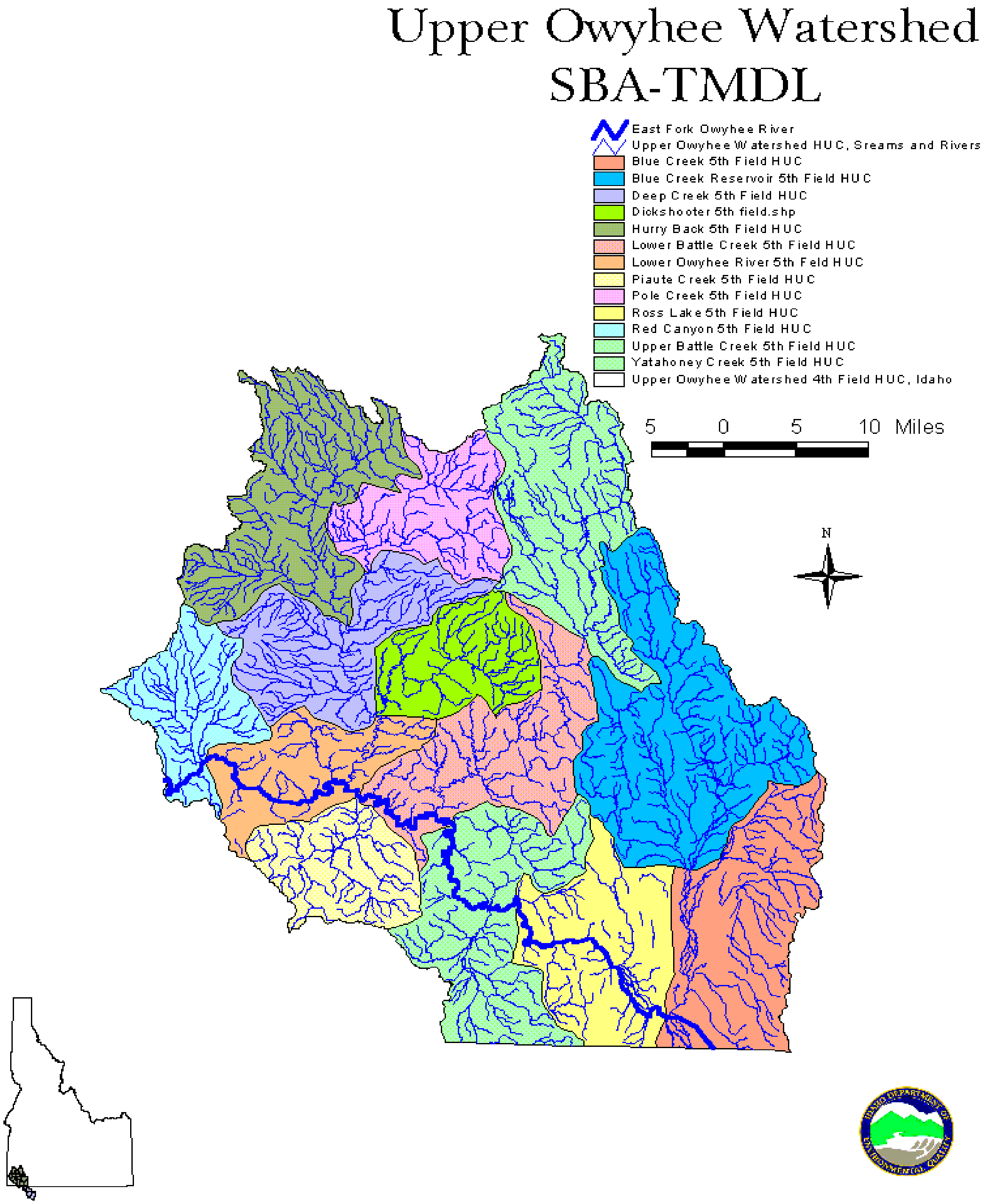


Figure 4. 5th Field HUCs. Upper Owyhee Watershed

Climate

There is one climate monitoring station within the Upper Owyhee Watershed: Owyhee, Nevada Station # 265869 (Climatic Service Center, Internet Retrieval 2001). Other stations within the immediate area are listed in Table 3. The three stations outside the watershed that most closely reflect expected weather conditions in the Upper Owyhee River Watershed are McDermitt, Nevada (Elevation 1390 meters, 4560 feet); Danner, Oregon (Elevation 1320 meters, 4330 feet); and Paradise Valley Ranches, Nevada (Elevation 1460 meters, 4790 feet) (Western Regional Climate Center 1999). Juniper Mountain is the highest elevation within the watershed at approximately 2090 meters (6857 feet). The lowest elevation is located at the confluence of the East Fork Owyhee River and the South Fork Owyhee River at approximately 1250 meters (4100 feet).

The canyons and plateaus of the East Fork Owyhee River, Battle Creek, Red Canyon Creek and Deep Creek likely receive between 9 and 11 inches of precipitation annually. There is probably not a permanent wintertime snow accumulation below 1400 meters (4593 feet) elevation (canyons or lower plateaus). However, Juniper Mountain and the Owyhee Mountains accumulate substantial snowfall during the winter (SNOTEL Sites: Mudflats Site #654 and South Mountain Site # 774, 2001)(NRCS 2001a).

Temperatures average 26-29 ^{o}C (80-85 ^{o}F) during summer months, but in all likelihood exceed 37 ^{o}C (100 ^{o}F) on occasion during June, July and August. Overnight temperatures in the canyon areas may be affected by several factors. “Cold pooling” may result in pockets of cool air. Drainage winds may also cause mixing and create warmer air. Sheltered areas may also have areas that maintain higher temperatures from daily heating due to surrounding igneous geology.

The plateaus and the Juniper Mountain area are more subject to gradient winds, daytime heating and nighttime cooling. These higher elevations are also more subject to summertime thunderstorms. As warm thermal air rises from northern Nevada and is rapidly cooled as it ascends up mountain slopes, summertime thunderstorms are sometimes produced.

Table 3. Climatic Summary, Available Weather Information (Western Regional Climatic Center 1999). Upper Owyhee Watershed.

Station and Station Identification	Paradise Valley, Nevada[a] (266005)	Three Creeks, Idaho[b] (109119)	Danner, Oregon[c] (352135)	Owyhee, Nevada[d] (265869)	McDermitt, Nevada[e] (264935)
Elevation meters (feet)	1460 (4790)	1690 (5544)	1320 (4330)	1690 (5544)	1390 (4560)
Max Average Temp, June-thru September (in °F/ °C)	84.7/29.3	80.1/26.7	83.5/28.6	78.9/26.1	83.4/28.6
Min Average Temp, June thru September (in °F/ °C)	43.7/6.5	38.1/3.4	43.0/6.1	46.4/8.0	43.2/6.2
Average Precip. (inches)	10.1	12.9	11.6	14.6	9.6
Average Snow accumulation (inches)	28.9	73.1	25.2	69.1	9.0

a.Period of Record 1948 through 1998, b. Period of Record 1940 through 1987, c.Period of Record 1930 through 1998, d.Period of Record 1948 through 1985, e.Period of Record 1950 through 1998.

Hydrology/Morphology

Most of the Idaho §303(d) listed streams in the Upper Owyhee Watershed flow north to south. Deep, Nickel, Pole and Battle Creeks all originate in the Antelope/Combination Ridge areas of the Owyhee Mountains. Castle and Red Canyon Creeks originate in the Juniper Mountain area and are fed by numerous 1st and 2nd order streams. Terrain in the upper watersheds (1st and 2nd order streams) is steep with the larger order streams (3rd, 4th and 5th) flowing into wet meadows, plateau areas and the incised canyons of the YP Desert. Shoofly Creek, the only stream outside the Owyhee Mountain area, originates in the rolling hills north of the tribal lands of the Duck Valley Indian Reservation. The main characteristic of this area is wide valley bottom types. Figure 5 shows the overall hydrology of the entire Upper Owyhee Watershed. Appendix B provides statistics and maps of individual 5th field HUC watersheds.

Juniper Basin and Blue Creek Reservoirs are located in the Yatahoney and Blue Creek Reservoir 5th field HUCs, respectively. Both dams are earthen structures. Juniper Basin Reservoir constructed in 1923 (IDWR 1971), was designed as a storage reservoir for irrigation water. It has since fallen into disrepair. The reservoir is mainly used for livestock watering. The dam is privately owned, but is entirely on lands managed by the BLM (IDWR 1971). See photos in Appendix E. The Idaho Department of Transportation 1:100,000 scale map (Riddle) shows a stagnate elevation of the reservoir at 1537 meters (5042 feet), with the total capacity at 1540 meters (5052 feet). It is calculated at the stagnate elevation the reservoir size is approximately 750 acres. At full capacity, the reservoir area doubles. The maximum depth is approximately 5 meters (16 feet), with a stagnate elevation depth of 2 meters (6.5 feet). The storage capacity is 500 acre feet (IDWR 1971). The Juniper Basin Reservoir Watershed is approximately 20,000 acres, with some of the headwaters located in Nevada. Waters flowing into the reservoir are intermittent and ephemeral.

Blue Creek Reservoir was constructed in 1935 and is privately owned, but is entirely on lands managed by the BLM (IDWR 1971). The dam is used to govern flow into Blue Creek and supplies irrigation water to the agricultural areas downstream. Releases from the reservoir are made into the Blue Creek channel at the base of the dam. Irrigation water is then removed from the creek at small diversion structures. The elevation of the reservoir is 1648 meters (5407 feet). The total reservoir size is approximately 185 acres; maximum depth is approximately 8 meters (26 feet). Water depth and reservoir size can fluctuate due to irrigation water demand. The storage capacity is listed at 250 acre feet (IDWR 1971). The 5th field Blue Creek Reservoir HUC encompasses approximately 107,000 acres. The watershed above the reservoir is approximately 30,000 acres. Blue Creek above the reservoir is usually perennial. However, in 2001, the creek was dry directly above the reservoir. Although the Idaho Department of Fish and Game (IDFG) had planted domestic Kamloops trout in the reservoir, it is not known if a conservation pool has been established or if there is adequate habitat for fish reproduction (IDFG 2001b).

Historic flow data is lacking on any of the listed streams within the 4th field HUC number 17050104 in the state of Idaho. Within the state of Nevada there are five historic water flow data sites, all on the East Fork Owyhee River. All these sites are below the Wild Horse Reservoir and would not reflect unregulated flows.

During the last two monitoring seasons, 2000 and 2001, Pole Creek, Red Canyon Creek and Castle Creek have either dried up completely at established monitoring sites, or were intermittent as defined in the *State of Idaho Water Quality Standards and Wastewater Treatment Requirements* (WQS) (IDAPA§ 58.02.0107.07). Nickel Creek is spring fed, but goes dry upstream of the springs during summer months. There did not appear to be any difference in the flow levels in 2000 and 2001. Nickel Creek was not evaluated for flow below Mud Flat Road to the confluence of Deep Creek. Shoofly Creek dried up upstream of Bybee Reservoir, but remained flowing below the reservoir, mainly for irrigation purposes.

It is not certain if the streams mentioned above go dry annually or if this condition was caused by drought conditions that occurred in southwest Idaho over the last two years. Since there are no historic or permanent flow gages within the Idaho portion of the HUC, it is difficult to determine the frequency streams become dry.

Springs and seeps are present in all watersheds within the Upper Owyhee Watershed and appear to be mostly a product of the geological formations. Like Nickel Creek, springs are the main source of water for many of the streams. However, it is not known what effect the drought conditions of the last two years may have had on these springs. In previous drought conditions, many springs have gone dry after one or two years of extremely low snowpack. Many of the major springs are located at similar elevations between 1640 and 2030 meters (5380 and 6660 feet). Headwater springs in the Juniper Mountain area are consistently near 1900-2000 meters (6233-6562 feet) elevation.

Many of the headwater streams are B channel types (Rosgen 1996), which indicate higher gradient with a gravel or gravel-sand substrate. Some of the headwater streams flow through steep canyons with higher gradient and a boulder-cobble substrate. As the streams naturally incised into the parent geological material, the gradient lessened, the confinement increased and these streams formed into F channel types (Rosgen 1996). Aerial photos (BLM 24 ID-91-AC) show these confined channels have large gravel and sand bar formations at the inside and end meander points and at pool tailouts. The lower gradient C channel types (wet meadows) are also evident, but many of these streams have become incised due to some change in hydraulic function and have formed into F-G channel types (Rosgen 1996). Many of these systems now lack adequate access to the historic floodplain.

The incised old C channel type systems may or may not be associated with current land use practices. Many of the old channels and meanders are above the current stream elevation, indicating downcutting in recent history. This downcutting could be associated with natural conditions, but most likely began with the removal of beavers in the early 1800s. The removal of the beavers and the beaver dams changed the overall hydraulics of the systems. These beaver dams once played an important role in maintaining finer course material behind the dams. Once these dams failed, the streams started downcutting into the finer substrate until they met a more stable substrate. As these systems stabilized, access to the floodplain once again became important for stabilizing the streams and the streambanks. Current land use practices have complicated the situation by removing vegetation that assists in reducing stream water velocity and the deposition of fine sediment (Thomas et al. 1998 and Dupont 1999a).

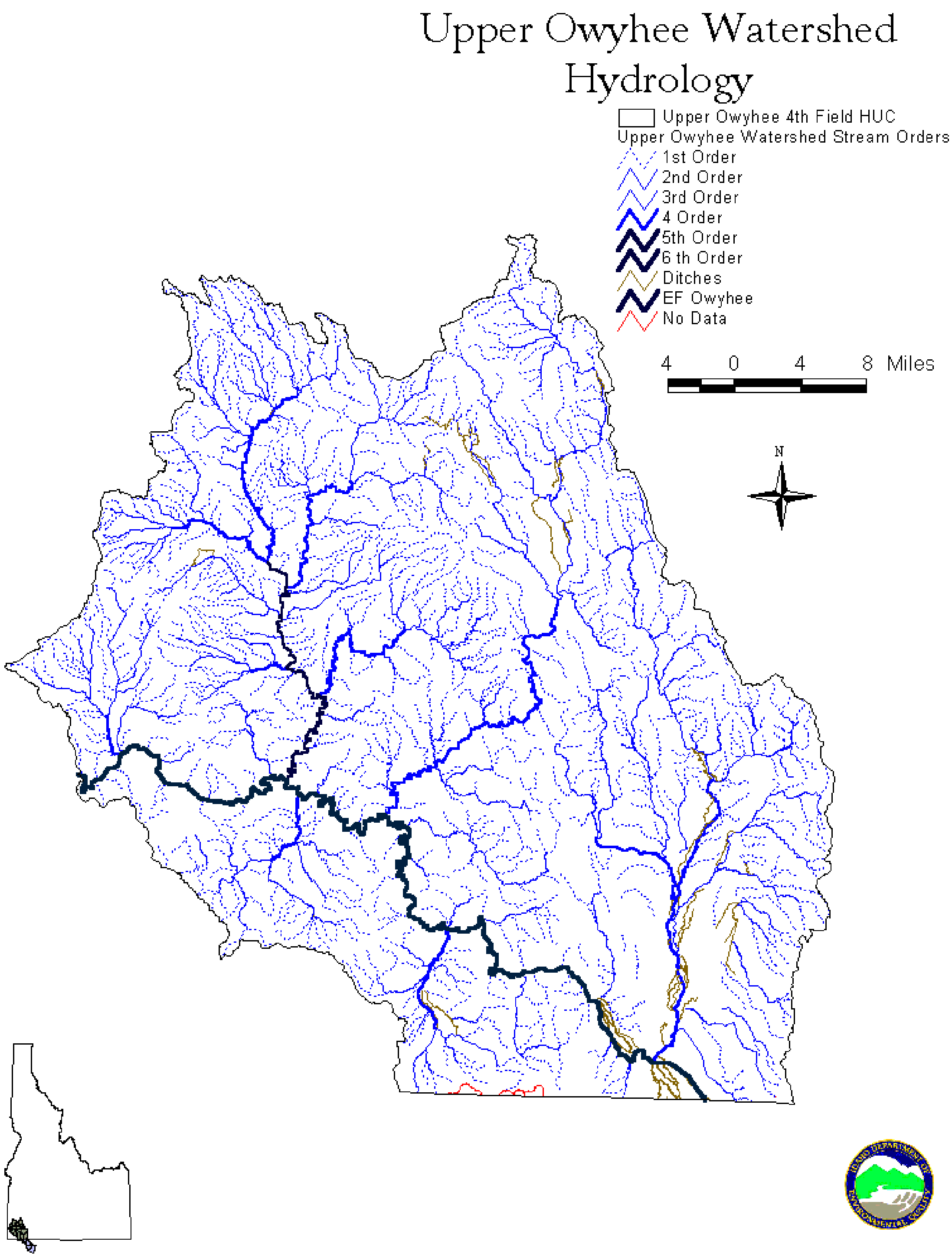


Figure 5. Overall Hydrology. Upper Owyhee Watershed

Geology/Soils

The Owyhee-YP Desert is composed of complex overlays of rhyolitic ash-flow tuffs, basalt flows and intercalated sedimentary rocks. The basement rocks, consisting of Mesozoic intrusive and metamorphic units, crop out within the Owyhee Mountains, which make up the northern boundary of the HUC. Most of the general characteristics of the local geology are due to past activity of Juniper Mountain, which is responsible for the rhyolitic ash-flow tuffs in the area approximately 8-11 million years ago (Minor et al. 1987, Swalan et al. 1987, Goeldner et al. 1987). Basalt flows can be seen in Castro Table, Little Point, Black Table, Lambart Table and Spring Butte.

It is these layers of the rhyolitic ash-flow tuffs, and their exposure, which make up the canyons of Deep Creek, Red Canyon Creek, and Battle Creek. The East Fork Owyhee River canyon is more associated with basalt-rhyolitic ash-flow tuffs flow activity from the Swisher Mountain flows (Swalan et al. 1987). These canyons are as deep as 300 meters (984 feet) in some locations.

Soils within the high plateau areas are a thin veneer of sediment from alluvial, fluvial, colluvium, ancient lakebeds and landslide sources. Soils are generally characterized as acidic/xeric or soil moisture regime and mesic frigid soil temperature regime. Soils are classified as silt loams to clay loams and range from shallow to deep. Rock fragments can be found scattered in the soil and within the soil profile. Figure 6 and Figure 7 show the overall geological formation and the soil profiles of the Upper Owyhee Watershed.

Stream sediment is mostly of alluvial origin. However, in steep canyon areas, large boulders can be found from landslides and talus slopes. In areas where stream gradient lessens, sandy or sandy-loam soils can be found. The depositional area in the larger streams is usually associated with flashy storm event flows or springtime flooding.

Smaller 3rd order stream (Castle Creek, Pole Creek) valley bottom types dictate stream morphology and near stream soils. In many areas the remnants of beaver dams can be seen, which would indicate stream channel buildup associated with the trapped sediment. As beavers were removed and dams failed, the streams cut down through the depositional areas of fine alluvial deposits (fine sediment and sands).

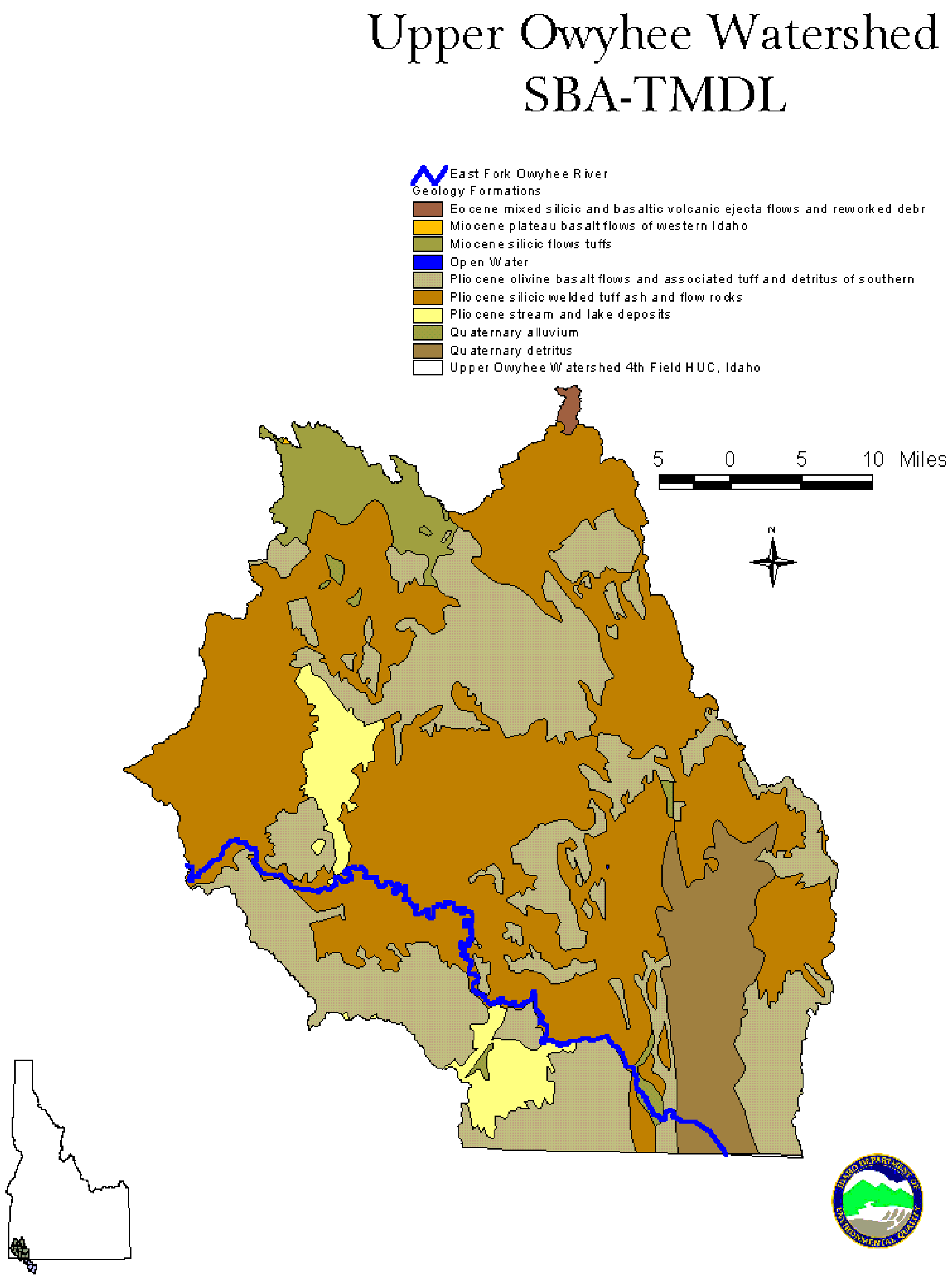


Figure 6. Geology. Upper Owyhee Watershed.

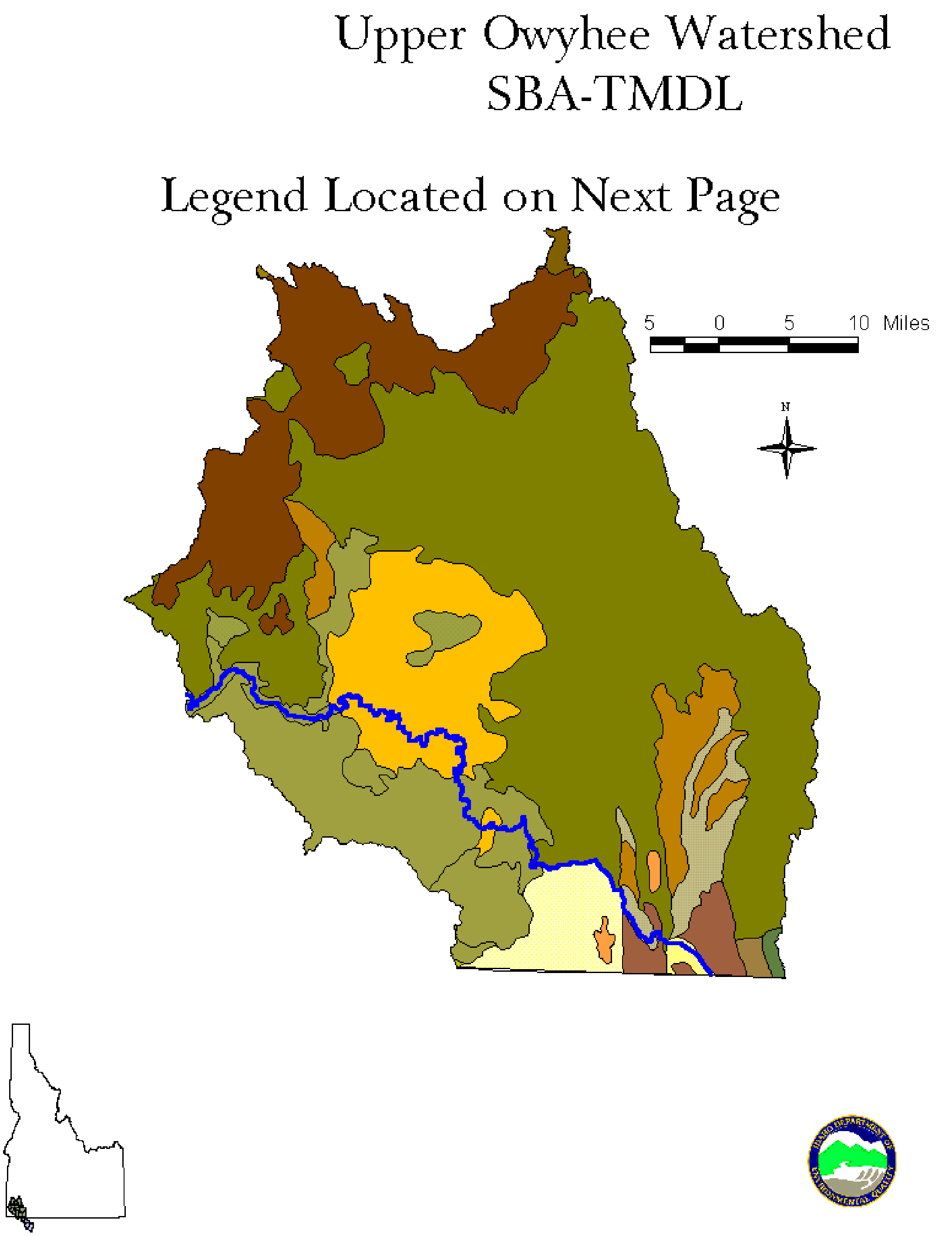


Figure 7. Soils. Upper Owyhee Watershed

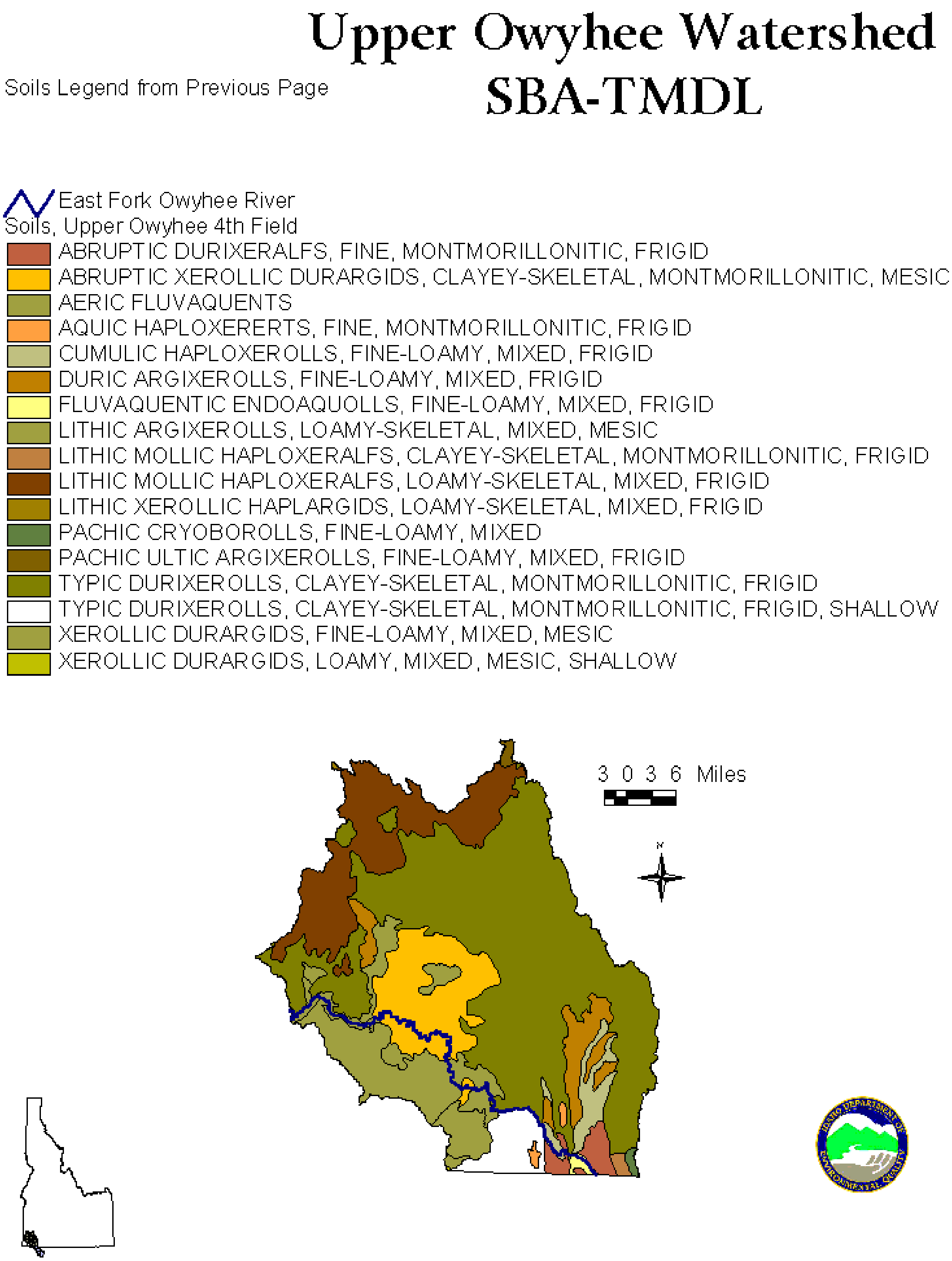


Figure 7. (Cont.) Soils. Upper Owyhee Watershed.

Biological Information

Endangered Species

The *Owyhee Resource Management Plan and Final Environmental Impact Statement* (ORMP) (BLM 1999) has listed 31 species of plants that are "special status plants" and 50 animal species that are classified as "special status animal species." These plants and animals may be endangered, threatened, candidate for listing, state endangered, state species of special concern, or BLM sensitive species. Only one plant, Ute ladies' tresses (*Spiranthes diluvialis*) is listed as threatened, and no endangered plant species are listed in the Upper Owyhee Watershed. For animals, only the bald eagle (*Haliaeetus leuococephalus*), peregrine falcon (*Falco mexicanus*) and the gray wolf (*Canus lupus*) are listed as threatened or endangered. There are numerous state species of special concern including redband trout (*Oncorhynchus mykiss gairdeneri*), which can be found in streams in the Upper Owyhee Watershed (USDI-BLM 1999). There are no federally listed endangered fish species associated with the Upper Owyhee Watershed (BLM 1999). Although this list of special status plants and animals species originated from ORMP, which applies to areas west of Deep Creek, it is assumed that species composition and communities are similar in eastern areas of the watershed.

Plant Communities

As seen in Table 4, rangeland makes up the largest portion of land use in the Upper Owyhee Watershed. The majority of these areas are the sagebrush steppe ecosystem, with low sagebrush (*Artemisia arbuscula*) communities dominating most of the lower elevations of the YP-JP Desert. Most of these areas are associated with flat sage covered plateaus split by deep canyons. Mountain big sagebrush (*Artemisia tridentata*) communities can be found in higher wetter elevations and north slopes. Understory communities are naturally assorted Idaho fescue (*Festucae idahoenis*), bunchgrass and bluegrass (*Poa sp.*). In some areas, cheatgrass has invaded the area.

Western juniper (*Juniperus occidentalis*) has invaded into areas that in the past were dominated by either mountain big sagebrush or low sagebrush communities. Only a small portion of the Upper Owyhee Watershed would be classified as having western juniper as the potential climax species (BLM 1999). This invasion and the subsequent depletion of sage/grass lands can be associated with the current land use, frequency of fire and possible climatic changes (Bedell et al. 1991).

Riparian areas are areas of vegetation growing along stream/river corridors. Riparian areas are made of a complex vegetation structure of herbaceous or woody species, and are valuable for biodiversity. Woody species could include willow (*Salix sp.*), cottonwoods (*Populus sp.*), alders (*Alnus sp.*), aspen (*Populus sp.)*, and dogwood (*Cornus sp.*). Herbaceous species may include rushes (*Juncus sp.*), sedges (*Carex sp.*) spiked rushes (*Eleocharis sp.*), and other mixed Gramineae species, both hydrophilic and hydrophobic.

Past and current land use has altered the vegetation composition of many of the riparian and upland areas. As streams down-cut and become incised there is a loss of access to historic floodplains; shallow near stream ground water storage is also lost (Thomas et al. 1998). This has brought on an invasion of hydrophobic species, including western juniper, almost to the water's edge. This invasion and presence of hydrophobic species on Red Canyon Creek and upper elevation reaches of Deep Creek and Pole Creek are most notable. In the uplands, non-native grasses such as cheat grass (*Bromus sp.*) has invaded into areas following a disturbance such as wildfire.

In low stream gradient areas, some of the old wet meadow riparian areas may have been converted to irrigated pasture or hay fields. This has altered the composition of native species. Introduced herbaceous species such as brome grass (*Bromus sp*.), Timothy grass (*Phleum sp*.), redd canary grass (*Phalaris sp*.), tall wheat grass (*Agropyron sp*.), orchard grass (*Dactylis sp*.), rye grasses (*Elymus sp*.) and other nonnative species may now dominate some of these areas.

Fisheries

There is evidence of the prehistoric presence of anadromous fish in the Upper Owyhee Watershed and the East Fork Owyhee River (Plew 1985). During an archaeological dig near Pole Creek, the remains of a steelhead trout were located in the Nahas Cave. This may indicate prehistoric anadromous spawning in the smaller tributaries such as Deep Creek, Pole Creek and other 3rd or 4th order streams in the Upper Owyhee Watershed. Anadromous fish are no longer present due to impassable barriers downstream on the Owyhee River in Oregon and other barriers on the Snake River.

Although current fish data are limited, there are some studies that have occurred in the Owyhee County area. Some of these studies either involved the actual capture of fish; others involved personal observations. Allen, et al. (1993, 1995, 1996, 1997 and 1998) has provided documentation of the presence of a variety of species found in the Owyhee Desert. Allen inventoried smallmouth bass (*Micropterus dolomieui)*, sculpins (*Cottus sp.*), bridgelip suckers (*Catostomus columbianus*), mountain sucker (*Catostomun platyrhynchus*), chiselmouth (Acrocheilus *alutaceus*), mountain whitefish (*Prosopium williamsoni*), redside shiners (*Richardsonius balteatus*), speckled dace (*Rhinichthys osculus*), longnose dace (*Rhinichthys cataractae*), northern pikeminnows (*Ptychoccheilus oregonenis*), largescale suckers (*Catostomus macrocheilus)*, and redband trout (*Oncorhynchus mykiss gairdeneri*). Only redband trout and mountain whitefish are classified as salmonid species.

The ORMP goes into some detail on the presence of redband trout within some portions of the Upper Owyhee Watershed. Although limited to Castle Creek, Deep Creek, Nip and Tuck Creek and Red Canyon Creek, the ORMP does indicate the presence of the species in most water bodies in the Upper Owyhee Watershed. The ORMP concentrated the evaluation effort on those water bodies to the west of Deep Creek.

Recent collection efforts by the BLM in Deep Creek, Pole Creek, Castle Creek, Camas Creek, Battle Creek and Nickel Creek have shown similar to those of Allen (Zoellick 2001). Few redband trout were counted in the 2000 BLM electrofishing effort, and no young of the year were documented. The BLM has not organized all fishery data from the 2000 collection effort, and there is still some evaluation occurring.

The IDFG did not provide any information on recent studies completed in the Upper Owyhee Watershed. Except for the fish stocking in Blue Creek Reservoir, there is no other evidence any other stocking effort has occurred in the Upper Owyhee Watershed. It should be noted that the *2001-2006 Fisheries Management Plan* lists all streams in the Upper Owyhee Watershed to be managed for mixed fisheries, except for Deep Creek, Battle Creek and Blue Creek (IDFG 2001b). These streams and their tributaries are to be managed for wild redband trout. Mixed fisheries is defined as those waters that support a combination of cold water and warm water species (IDFG 2001b).

The designation of Deep Creek, Battle Creek and Blue Creek for management of wild redband trout is interpreted as a management plan for desirable species, including the self propagation of desirable species. The state WQS specifically state that "wherever attainable, surface waters of the state shall be protected for beneficial uses which for surface waters includes all recreational use in and on the water surface and the preservation and propagation of desirable species of aquatic life (IDAPA§ 58.01.02.050.02.a)." The state WQS also state "In all cases, existing beneficial uses of the waters of the state will be protected" (IDAPA§ 58.01.02.050.02.a).

A search of the Idaho DEQ Beneficial Use Reconnaissance Program (BURP) database provided some additional information on fisheries. Electrofishing had occurred on four sites in 1995 and 1996. (BURP ID#1995SBOIB010 [Deep Creek Lower], BURP ID#1995SBOIB012 [Deep Creek Upper], BURP ID#1995SBOIB014 [Pole Creek], and BURP ID# 1996SBOI019 [Castle Creek]).

Results from the BURP effort showed mostly nongame species of bridgelip suckers (*Catostomus columbianus*), redside shiners (*Richardsonius balteatus*), chiselmouth, (*Acrocheilus alutaceus*), northern pike minnows (*Ptychoccheilus oregonenis*), largescale suckers (*Catostomus macrocheilus*), speckled dace (*Rhinichthys osculus*), longnose dace (*Rhinichthys cataractae*), and sculpin (*Cottus sp.*). Smallmouth bass (*Micropterus dolomieui*) was the only game species recovered. No redband trout were found during the BURP fish monitoring effort.

Benthic (Benthos) Communities

Benthic communities are references to any living organisms that can be found on the bed (substrate) of streams or any other water body. The benthic community can consist of insects (macroinvertebrates), worms (Oligochaeta), algae (periphyton), vascular plants (macrophytes), or any other living organisms (bacteria, fungi, etc.).

The BURP sampling has focused mainly on macroinvertebrates as indicators of support of beneficial uses, mainly cold water aquatic life (CWAL). BURP data for streams in the Upper Owyhee Watershed showed the macroinvertebrate community consisted of the orders of Diptera (flies), Odonata (dragonflies, damselflies), Coleoptera (beetles), Trichoptera (caddisflies), Ephemeroptera (mayflies) and Oligochaeta (worms). Some studies that have either focused on the Owyhee-YP Desert area or incorporated the area into a larger statewide evaluation can be found in Clark (1978), Clark (1979) and Robinson and Minshall (1994). Further analysis of macroinvertebrates is located in Section 2.3.

There were some collections and analyses of the algae communities in the Upper Owyhee Watershed. On the ten streams receiving analysis for periphyton, the average pollution tolerance index was 2.54. The pollution tolerance index is based on sets of metrics on species present in samples and if species are tolerant of certain types of pollutants. The pollution tolerant index of 2.54 indicates the streams are slightly to moderately impaired by pollutants. More discussion of periphyton results from 2000 and 2001 are located in Section 2.3.

1.3 Cultural Characteristics

Past and Current Land Use

Evidence shows the Upper Owyhee Watershed has a long history of use by prehistoric Native Americans. Documentation by Plew (1985) indicates use by the prehistoric population was year round, with winter camps associated with the lower elevations of the East Fork Owyhee River Canyon. Upper elevations were used for hunting and gathering camps (Pole Creek, Camas Creek) during summer and fall. Carbon dated material shows the area has been inhabited over the last 6000 years (Plew 1985).

The first historic Anglo-European presence was probably associated with the beaver trappers in the late 1700s. Although mostly a high-arid desert, the streams and rivers within the Upper Owyhee Watershed at one time supported a viable beaver population. Past beaver activity can be noted in many of the irrigated pasture areas where fine sediment deposits have created fertile soils areas along stream corridors. Although no current trapping records are available, there appears to be sparse beaver activity currently in the Upper Owyhee Watershed (Personal Observation, Ingham 2001)

It was not until 1863 that a permanent presence of Anglo-European is documented (Adams 1986). Mineral deposits of gold and silver were discovered in the Jordan Creek area of the Silver City Range of the Owyhee Mountains. The first documented settlement (mining camp) was Ruby City, located on Jordan Creek. Other mining camps and new discoveries of deposits of gold and silver soon followed. This area supported numerous towns and camps throughout the late 1800s and through the early 1900s (Adams 1986). As the gold and silver deposits were mined out, towns were abandoned. Silver City is the only permanent settlement remaining. Some mining still occurs in the area, with extraction of gold from low grade ore. There are two permanent incorporated communities in the Upper Owyhee Watershed, Owyhee and Mountain City, Nevada. Scattered homesteads can be found on Tribal lands in Idaho, but no communities.

As the mining towns and camps flourished, many who could not find their riches in mining turned to supporting the mining population. Sheep and cattle businesses began to operate soon after ore deposits were discovered. Along with the spring-summer-fall open grazing, these operations needed areas for hay production for winter feed. The stream corridors provided these areas.

Table 4 shows the breakdown of current land use practices in the Upper Owyhee Watershed. Figure 8 shows a map of current land use. Although forested areas make up 7.5% of the total land type in the Upper Owyhee, actual timber harvest for lumber is non-existent. Most of the woodland areas are western juniper (*Juniperus occidentalis*) which has little commercial value, except for rough fencing material or firewood. More discussion of plant communities and seral conditions can be found in section 1.2.

Rangeland in this area is mostly part of the intermountain sagebrush province/sagebrush steppe ecosystem (BLM 1999). The sagebrush steppe ecosystem is widespread throughout northern

Nevada, southeastern Oregon and southern Idaho. Riparian and irrigated areas are usually located within the historic floodplains of stream and river corridors.

Table 4. Land Use, Total Acres and Percent of Total Acres. Upper Owyhee Watershed.

Land Use	Acres/Percent
Rangeland	889,562 acres (88%)
Irrigated Gravity	1,493 acres (<1%)
Irrigated Sprinkler	2,396 acres (<1%)
Riparian	42,856 acres (4%)
Forested	76,108 acres (7.5%)
Total	1,012,415 acres (100%)

Land Ownership/Management

Almost 74% of all lands within the Upper Owyhee Watershed are managed by the BLM, and most of this land is devoted to rangeland. The Bureau of Indian Affairs (BIA) is the other large federal land manager. The Duck Valley Indian Reservation extends into northern Nevada, but encompasses about 122,375 acres of the Upper Owyhee Watershed within Idaho.

Private holdings are found mostly in the riparian areas and make up about 6.5% of all land ownership. These areas are usually the more productive areas and may or may not be irrigated. Many of these private holdings were once independent ranches, such as the Star Ranch, Brace Brother's Ranch and Castro Ranch, but many now have been grouped into grazing associations. Other smaller holdings have also been bought by large corporations and incorporated into much larger operations.

Table 5, shows the breakdown of land ownership/management. Figure 9 shows the schematic of land ownership/management patterns. Appendix B has a complete breakdown of ownership/management by 5th Field HUC.

Table 5. Land Ownership/Management, Acres and Percent of Total. Upper Owyhee Watershed.

Ownership/Management	Acres/Percent
Private	65,653 acres (6.5%)
State of Idaho	37,428 acres (7.3%)
Federal/Bureau of Land Management	746,833 acres (73.8%)
Tribal lands	122,375 acres (12.1%)
Open Water	4,117 acres (0.4%)
Total	1,012,406 acres (100%)

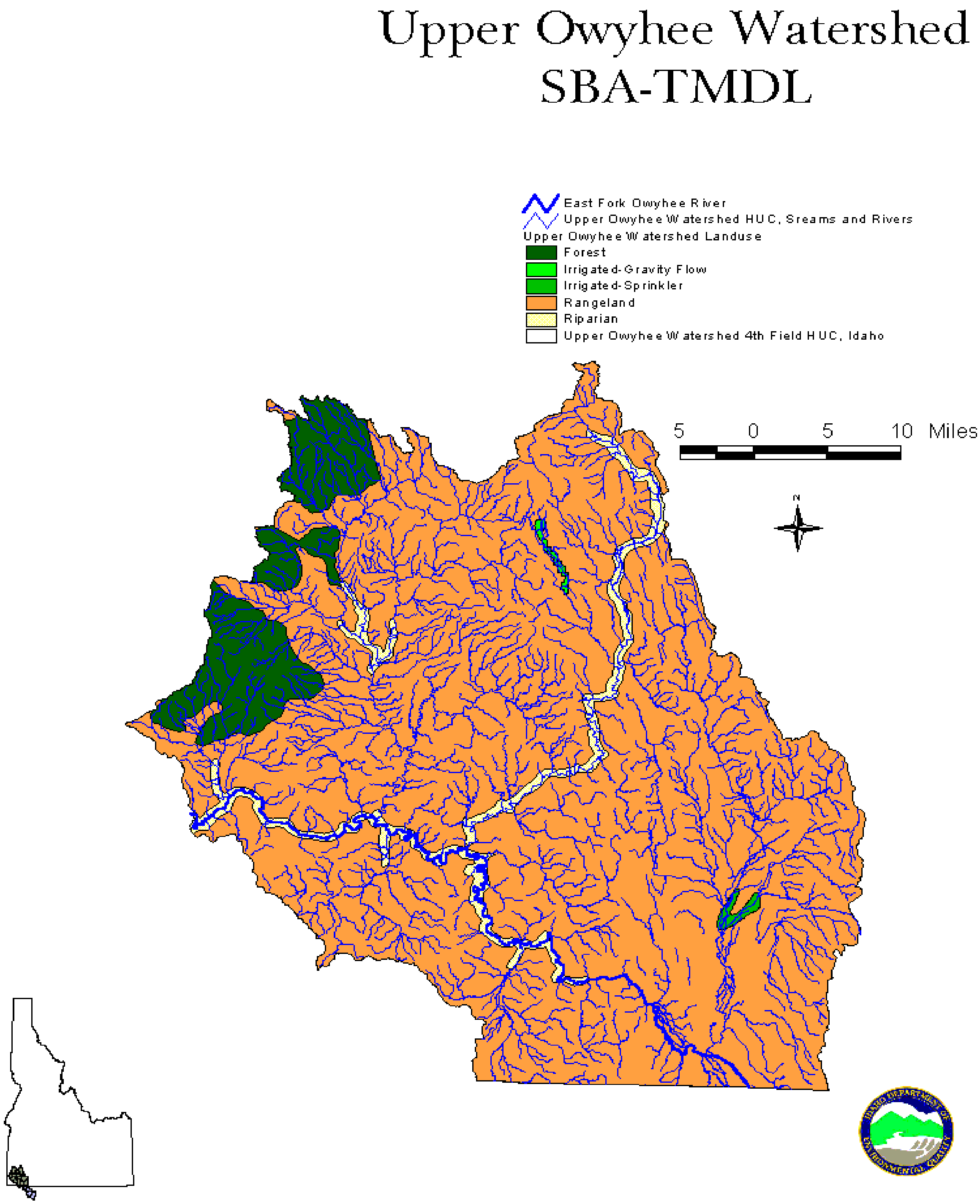


Figure 8. Land Use. Upper Owyhee Watershed.

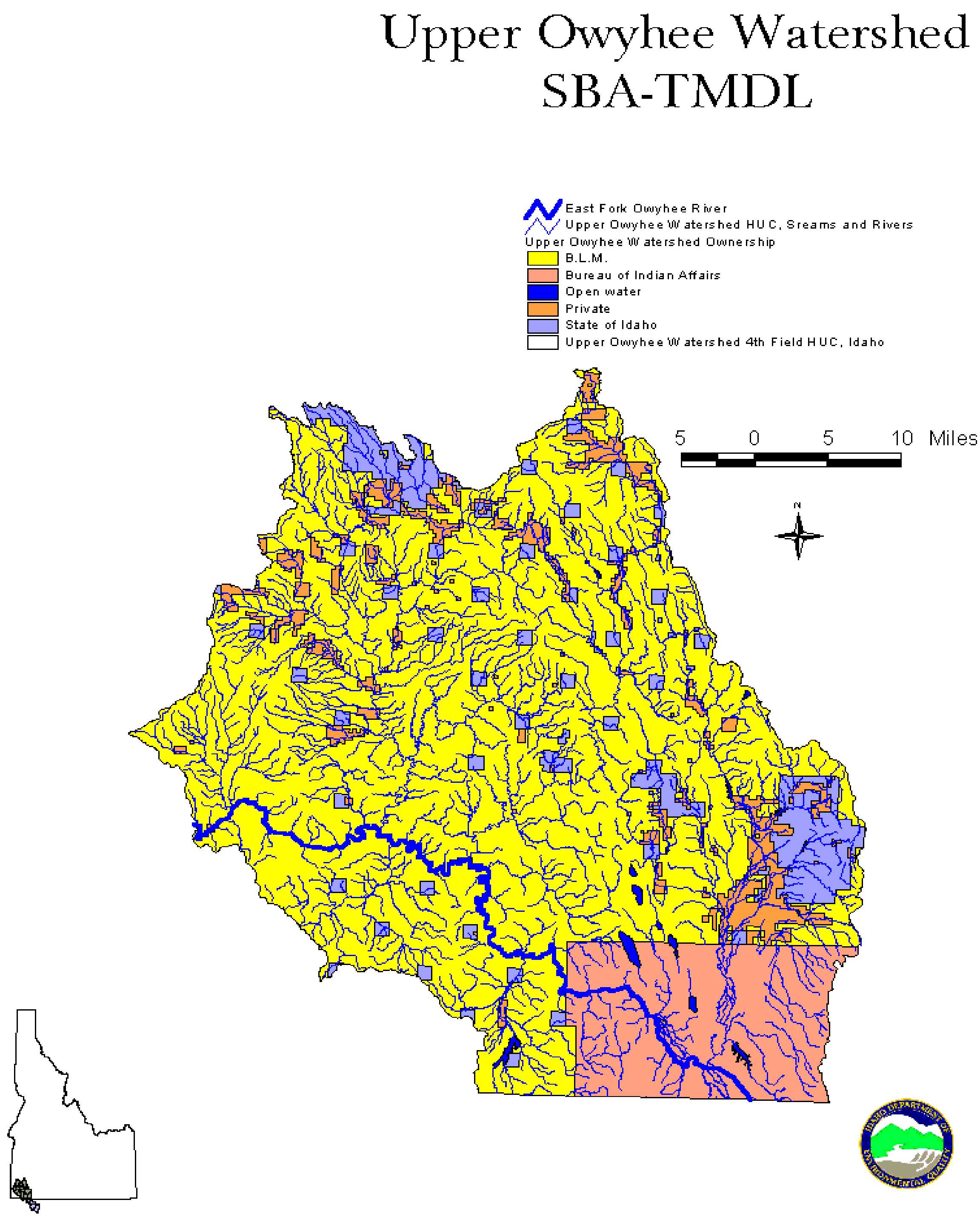


Figure 9. Land Ownership/Management. Upper Owyhee Watershed.

2. Subbasin Assessment – Water Quality Concerns and Status

2.1 Applicable Water Quality Standards

The State of Idaho *Water Quality Standards and Wastewater Treatment Requirements* (WQS), IDAPA§ 58.01.02 define the water quality goals of water bodies by designating uses and establishing numeric and narrative standards (ambient conditions) necessary to protect the designated and existing uses. Existing uses are those surface water uses actually attained on or after November 28, 1975, whether or not they are designated uses. Those water bodies not identified with a designated use will be protected for existing uses.

All waters are protected through the general surface water quality criteria. A narrative standard prohibits certain pollutants or conditions, which may impair designated or existing uses. For the state of Idaho, these pollutants include: hazardous materials; toxic substances; deleterious materials; radioactive materials; floating, suspended or submerged matter; excess nutrients; oxygen demanding materials; and sediment (IDAPA§ 58.01.02.200). Numeric standards for the support of designated uses and/or existing uses are set in IDAPA§ 58.01.02.250. The criteria include temperature, dissolved oxygen, bacteria counts and other values set to protect beneficial uses.

<u>Aquatic Life</u>

CWAL is a designated beneficial use for Red Canyon Creek (IDAPA§ 58.01.02.140.01.SW-34). There are numeric and narrative criteria within the state WQS to protect CWAL. Numeric standards for pH, total concentration of dissolved gases, toxic substances and chlorine can be found in IDAPA§ 58.01.02.250.02. Other standards specific to CWAL (dissolved oxygen, un-ionized ammonia, turbidity; and temperature) are located in IDAPA§ 58.01.02.250.02.c.

If the water body does not have CWAL as a designated use, but it can be determined CWAL is an existing use, then the numeric and narrative standards for the protection of CWAL apply. In the WQS, it is presumed that all waters of the state have CWAL as an existing use. It is through the SBA process that Idaho DEQ determines if CWAL is actually an existing use, or if other aquatic life is existing. If it is determined CWAL is not an existing use, then the water body will be assessed to determine if another aquatic life use exists (IDAPA§ 58.01.02.100.01).

Salmonid spawning is not a designated beneficial use for any listed water body within the Upper Owyhee Watershed (IDAPA§ 58.02.140.01). If it is determined through the SBA process that salmonid spawning is an existing use, then the criteria for the protection of salmonid spawning are applied. Criteria for the protection of salmonid spawning are listed under IDAPA§ 58.01.02.250.01. Numeric standards for pH, total dissolved gas, toxic substances and chlorine are specified in the WQS (IDAPA§ 58.01.02.250.01.). Other standards specific to salmonid spawning (dissolved oxygen, un-ionized ammonia, intergravel dissolved oxygen, and temperature) are located in IDAPA§ 58.01.02.250.02.e. The normal spawning period for salmonid species in the Upper Owyhee Watershed (redband trout) is March 1 through July 15.

Recreational Uses

All waters of the state are to be protected for primary contact recreation (PCR). However, if the water body cannot physically support PCR (i.e., lack of depth, lack of adequate flow, etc.) then secondary contact recreation (SCR) becomes the protected recreational use. The WQS (IDAPA§ 58.02.01.250.1) provide numeric criteria to determine support of both PCR and SCR.

The WQS (IDAPA§ 58.02.01.100.02.a. and b.) states the following for PCR and SCR:

> Primary Contact Recreation (PCR): water quality appropriate for prolonged and intimate contact by humans or for recreational activities when the ingestion of small quantities of water is likely to occur. Such activities include, but are not restricted to, those used for swimming, water skiing, or skin diving.
>
> Secondary contact recreation (SCR): water quality appropriate for recreational uses on or about the water and which are not included in the primary contact category. These activities may include fishing, boating, wading, infrequent swimming and other activities where ingestion of raw water is not likely to occur.

Agricultural Water Supply

Most waters of the state are protected for agricultural water supply (IDAPA§ 58.01.02.100.03.b.). In the WQS this is defined as, “Agricultural waters which are suitable for the irrigation of crops or as drinking water for livestock.”

Agricultural water supply can be impaired by nutrients, bacteria (along with viruses and protozoa), algae, sediment, flow modification, and other conditions that may affect the quality and quantity of water. There are no numeric state standards to determine support status. However, under IDAPA§ 58.01.02.200 agricultural water supply is protected under the general surface water quality criteria. *Water Quality Criteria 1972* (Blue Book), Section V, Agricultural Uses of Water (EPA 1973) will be used for determining criteria. Historical and current water quality information has demonstrated agricultural water supply is an existing use and is fully supported in the Upper Owyhee Watershed.

Domestic Water Supply

Domestic water supply is not a designated beneficial use for any §303(d) listed water bodies in the Upper Owyhee Watershed (IDAPA§ 58.01.02.140.01.). Domestic water supply is defined as water that is potable after treatment. There are no domestic water supplies within the watershed. Therefore, domestic water supply is not an existing use. The East Fork Owyhee River is designated for drinking water supply. However, there are no known withdrawals for this use.

Industrial Water Supply

All waters of the state, including the Upper Owyhee Watershed, are protected for industrial water supply (IDAPA§ 58.01.02.100.03.c). There are no numeric standards to determine support status.

However, under IDAPA§ 58.01.02.200 industrial water supply is protected under the general surface water quality criteria. Historical and present water quality information have not demonstrated industrial water supply as an existing use nor it is an impaired use.

Wildlife Habitat

All waters of the state, including the Upper Owyhee Watershed, are protected for wildlife habitat (IDAPA§ 58.01.02.100.04.). There are no numeric state standards to determine support status. However, under IDAPA§ 58.01.02.200 wildlife habitat is protected under the general surface water quality criteria. Historical and present water quality information demonstrate wildlife habitat is supported in the Upper Owyhee Watershed.

Aesthetics

All waters of the state, including the Upper Owyhee Watershed, are protected for aesthetics. There are no numeric state standards to determine support status. However, under IDAPA§ 58.01.02.200 aesthetics are protected under the general surface water quality criteria. Idaho DEQ has not received any formal complaints concerning water bodies and the aesthetic quality of the Upper Owyhee Watershed.

2.2 Designated Uses

Red Canyon Creek is the only §303(d) listed stream with designated beneficial uses set forth in the state of Idaho WQS. The WQS have listed both CWAL and PCR as designated uses (IDAPA§ 58.01.02.140.04 SW-34). Although not directly listed in IDAPA§ 58.01.02.140.04 SW-34, other designated uses include agricultural water supply, industrial water supply, wildlife habitat and aesthetics (IDAPA§ 58.01.02.100.03(a)(b)(c), IDAPA§ 58.01.02.100.04 and IDAPA§ 58.01.02.100.05). Table 6 describes the designated uses on the Idaho §303(d) listed in the Upper Owyhee Watershed.

Table 6. Designated Beneficial Uses. Upper Owyhee Watershed.

Water Body	Designated Uses[a]	1998 §303(d) list[b]
Blue Creek Reservoir	AWS, IDS, AS, WLH	
Juniper Basin Reservoir	AWS, IDS, AS, WLH	
Deep Creek	AWS, IDS, AS, WLH	
Pole Creek	AWS, IDS, AS, WLH	
Castle Creek	AWS, IDS, AS, WLH	
Battle Creek	AWS, IDS, AS, WLH	
Shoofly Creek	AWS, IDS, AS, WLH	
Red Canyon Creek	CWAL, PCR, AWS, IDS, AS, WLH	
Nickel Creek	AWS, IDS, AS, WLH	

a CWAL – Cold Water Aquatic Life, PCR – Primary Contact Recreation, AWS – Agricultural Water Supply, IDS-Industrial Water Supply, AS-aesthetics, WLH-Wildlife Habitat

b. Refers to a list created in 1998 of water bodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection "d" of the Clean Water Act.

2.3 Existing Beneficial Uses/Status

The primary purpose of this SBA is to determine if the listed streams conform to state of Idaho WQS. This is accomplished in four steps: 1) determine if a use is existing, 2) if the use is existing, determine compliance with WQS for use, 3) if the existing use is impaired, determine if impairment is associated with the pollutants listed on the 1998 §303(d) list; and 4) provide recommendations for future Idaho §303(d) lists.

Streams on the 1998 §303(d) list were placed there based on litigation, BURP monitoring, other agency data or best professional judgement. The state of Idaho presumes most waters in the state will support CWAL and PCR or SCR uses. In accordance with the WQS, the criteria to support the CWAL and PCR or SCR use is based on undesignated waters.

Questions remain on the beneficial uses and their status in the Upper Owyhee Watershed. For example, there is no data available that could be used to determine if any aquatic life exists in Juniper Basin Reservoir, nor could any data be found that would support placing the reservoir on the §303(d) list.

The SBA process attempts to answer questions concerning existing uses and use support. Due to the limitation of resources and time, usually only those pollutants listed on the §303(d) list are examined. Further evaluations were made to help fully understand what may be impairing a use, mainly CWAL (e.g., dissolved oxygen monitoring on Deep Creek, temperature monitoring on Nickel Creek). Further discussion of each §303(d) listed segment will follow. Table 7 describes the water bodies of concern and the determination of whether a use is existing and what the status of the use.

Table 7. Existing Use and Status for Listed Water Bodies. Upper Owyhee Watershed.

Streams	Cold Water Aquatic Life	Seasonal Cold Water Aquatic Life	Warm Water Aquatic Life	Modified Aquatic Life	Salmonid Spawning	Primary Contact Recreation	Secondary Contact Recreation
Blue Creek Reservoir	Existing/ Not Full Support	Not Evaluated	Not Evaluated	Not Evaluated	Not Existing	Existing/ Full Support	Existing/ Full Support
Juniper Basin Reservoir	Not Existing	Not Existing	Not Existing	Proposed	Not Existing	Existing/ Full Support	Existing/ Full Support
Deep Creek	Existing/ Not Full Support	Not Evaluated	Not Evaluated	Not Evaluated	Existing/ Not Full Support	Not Evaluated	Not Evaluated
Pole Creek	Existing/ Not Full Support	Not Evaluated	Not Evaluated	Not Evaluated	Existing/ Not Full Support	Not Evaluated	Not Evaluated
Castle Creek	Existing/ Not Full Support	Not Evaluated	Not Evaluated	Not Evaluated	Existing/ Not Full Support	Not Evaluated	Not Evaluated
Battle Creek	Existing/ Not Full Support	Not Evaluated	Not Evaluated	Not Evaluated	Existing/ Not Full Support	Existing/ Full Support	Existing/ Full Support
Shoofly Creek	Not Evaluated	Not Evaluated	Not Evaluated	Not Evaluated	Not Evaluated	Existing/ Full Support	Existing/ Full Support
Red Canyon Creek	Existing/ Not Full Support	Not Evaluated	Not Evaluated	Not Evaluated	Existing/ Not Full Support	Not Evaluated	Not Evaluated
Nickel Creek	Existing/ Not Full Support	Not Evaluated	Not Evaluated	Not Evaluated	Existing/ Not Full Support	Not Evaluated	Not Evaluated

Blue Creek Reservoir (WQLS #2627)

Blue Creek Reservoir does not have designated beneficial uses except for water supply, aesthetics and wildlife habitat (IDAPA§ 58.01.02140.04.). There is no indication that these uses are impaired. Existing uses include PCR or SCR, and CWAL. The CWAL and salmonid spawning existing uses are based on fish stocking conducted by IDFG in June 1999. Approximately 6,000 catchable domestic Kamloops trout were placed in the reservoir (IDFG 2001b). The listed pollutant of concern is sediment. It is not clear how Blue Creek Reservoir was placed on the 1998 §303(d) list. The IDFG has not provided any information on follow-up evaluation of fish survivability, reproduction or creel success.

Limited water quality monitoring was conducted in 2001 in Blue Creek Reservoir. Table 8 shows the results from monitoring in the reservoir conducted in 2001. More discussion of the data analysis is located in Section 2.4.

Table 8. Monitoring Results for Blue Creek Reservoir July 7, 2001. Upper Owyhee Watershed.

Site	Chlorophyll a (ug/l)	Diss. O-phosphate as P (mg/l)	Total Phosphorus (mg/l)	Total $NO_2 + NO_3$ as N (mg/l)	Total Suspended Solid (mg/l)	Turbidity (NTUs)
Reservoir at Surface (0.5 meters)	24.2	0.104	0.240	0.005	23	67
Reservoir at Bottom (3.2 meters)	NA	0.108	0.224	0.009	25	64

Juniper Basin Reservoir (WQLS #2627)

Juniper Basin Reservoir does not have designated beneficial uses except for water supply, aesthetics and wildlife habitat (IDAPA§ 58.01.02140.04.). There is no indication that these uses are impaired. Existing uses include PCR or SCR. The listed pollutant is sediment. It is not clear how Juniper Basin Reservoir was placed on the 1998 §303(d) list. Limited water quality monitoring was conducted in 2001 in Juniper Basin Reservoir.

Juniper Basin Reservoir is a shallow reservoir primarily constructed to deliver irrigation water. The irrigation system has been in disrepair for a long period of time and is totally inoperative. Livestock watering may be the only agricultural water use. It is unknown at this time if the main release valve from the reservoir is capable of releasing water from the reservoir. The reservoir is shallow and during a period in July 2001, the deepest part of the reservoir measured less than 2 meters (6.5 feet). Although not measured, in October of the same year the water depth was even less. Table 9 shows the monitoring results for Juniper Basin Reservoir conducted in July 2001.

Table 9. Monitoring Results for Juniper Basin Reservoir, July 6, 2001. Upper Owyhee Watershed.

Site	Chlorophyll a (ug/l)	Diss. O-phosphate as P (mg/l)	Total Phosphorus (mg/l)	Total $NO_2 + NO_3$ as N (mg/l)	Total Suspended Solid (mg/l)	Turbidity (NTUs)
Reservoir at Surface (0.5 meters)	25.5	NA	0.199	<0.005	11	72
Reservoir at Bottom (1.2 meters)	NA	NA	0.216	<0.005	14	72

The substrate is a deep layer of a fine sediment/clay type material. Substrate sampling with a dredge like device (Ponar) resulted in no material greater than silt size. More discussion of the data analysis is located in Section 2.4.

Inflow to Juniper Basin Reservoir during the summer months is non-existent. Juniper Creek and other streams upstream of the reservoir are ephemeral or intermittent streams.

Deep Creek (WQLS # 2614)

Deep Creek does not have designated beneficial uses except for water supply, aesthetics and wildlife habitat as specified in IDAPA§ 58.01.02140.04. There is no indication that these uses are impaired. Existing uses include CWAL, salmonid spawning and PRC or SCR. The existing uses of CWAL and salmonid spawning are based on the IDFG management plan to manage the watershed for wild redband trout (IDFG 2001b). The listed pollutants are temperature and sediment.

Idaho DEQ identified Deep Creek as beginning at the confluence of Nip and Tuck Creek and Hurry Back Creek (USGS 7.5 minute quadrangle map, Hurry Back). Deep Creek is approximately 46 miles long. When it reaches its confluence with the East Fork Owyhee River it is a 5th order stream. For much of its length, it is in a deep incised canyon with poor vehicle access. Aerial photos show the system has high flashy flows in the lower segment (canyon section) with large sediment deposits on the inside of meanders. The creek also has long wide glide areas feeding into short riffles. Deep Creek had continuous flow throughout the 2000 and 2001 monitoring seasons.

Three monitoring sites were established on Deep Creek (Ingham 2000). Temperature loggers were placed at these sites, and data were collected over an 18-month period. Biological, physical and chemical data were also collected at these sites.

Allen et al. (1993) found no redband trout at any sites in Deep Creek. However, a high density of redband trout was found in Nip and Tuck Creek approximately 2 miles upstream of the confluence with Hurry Back Creek (where the two join to form Deep Creek).

Idaho DEQ has two established BURP monitoring sites on Deep Creek. Table 10 shows the stream macroinvertebrate index (SMI) scores for the years monitoring was conducted.

The SMI scores indicate CWAL indicator species are present at the lower Deep Creek site at the road crossing. At the upper site near Mud Flat Road (also called Deep Creek Road), SMI scores indicate the site may or may not be supporting CWAL. Under the current edition of the *Water Body Assessment Guidance* (Idaho DEQ 2002), the SMI scores are rated as follows:

SMI	Support Status
>58	Condition Rating 3
49-57	Condition Rating 2
31-48	Condition Rating 1
<31	Minimum Threshold

Temperature data collected in 2000 and 2001 show temperatures exceeded the WQS for CWAL and salmonid spawning. More discussion of the data analysis is located in Section 2.4.

Table 10. Stream Macroinvertebrate Index Scores for Deep Creek. Upper Owyhee Watershed.

BURP ID # (year)	Description	Public Land Survey Description	SMI Score
1995SBOI012	Deep Creek near Mud Flat Rd.	10S 3W Sec 3	22.33
1995SBOIC006	Deep Creek near Mud Flat Rd.	10S 3W Sec 3	24.33
1996SBOI021	Deep Creek near Mud Flat Rd.	10S 3W Sec 3	65.82
1997SBOIA032	Deep Creek near Mud Flat Rd.	10S 3W Sec 3	50.73
1998SBOI023	Deep Creek near Mud Flat Rd.	10S 3W Sec 3	60.57
1995SBOI010	Deep Creek @ Lower Road Crossing	12S 3W Sec 11	45.55
1995SBOIC005	Deep Creek @ Lower Road Crossing	12S 3W Sec 11	41.78
1996SBOI018	Deep Creek @ Lower Road Crossing	12S 3W Sec 11	48.5
1997SBOIB031	Deep Creek @ Lower Road Crossing	12S 3W Sec 11	46.48
1998SBOIA022	Deep Creek @ Lower Road Crossing	12S 3W Sec14	51.46
1999SBOIA007	Deep Creek @ Lower Road Crossing	12S 3W Sec 11	62.17

Pole Creek (WQLS # 2617)

Pole Creek does not have designated beneficial uses except for water supply, aesthetics and wildlife habitat (IDAPA§ 58.01.02140.04.). There is no indication that these uses are impaired. Existing uses include CWAL, salmonid spawning and PCR or SCR. The existing uses of CWAL and salmonid spawning are based on BLM observations of redband trout in Pole Creek, mostly from the confluence with Deep Creek upstream to Indian Crossing (Zoellick, 2001). Allen et al. (1993) had no success in finding redband trout. The IDFG management plan includes management of the watershed for wild redband trout (IDFG 2001). The listed pollutants of concern are sediment, temperature and flow alteration.

Pole Creek was monitored in 2000 and 2001. The creek went dry about the end of August 2000 and in mid-July 2001. Biological assessments were conducted in June 2000. In accordance with the WQS, standards apply to intermittent waters during optimum flow periods sufficient to support the uses for which the water body is designated. For recreation and water supply uses, optimum flow is equal to or greater than 5 cfs. For aquatic life uses, optimum flow is equal to or greater than 1 cfs (IDAPA§ 58.01.02.07.07).

The USGS 7.5 minute quadrangle map (Wagon Box Basin) shows that most of Pole Creek is a perennial stream, but does become intermittent below the Idaho DEQ temperature logger site. Below the confluence with Camas Creek the segment becomes perennial again. There are a few small storage impoundments in the watershed along with some spring developments for livestock watering. There is also some evidence of historic irrigation water withdrawals near Mud Flat Road, but it is not known if these systems are still used.

Water temperature data are available for an 18-month period at the Idaho DEQ site near the headwaters. Biological information was collected in June 2000 at the same site. The BLM collected some fish data in September 2000. The BLM also had temperature loggers placed at 2 sites on Pole Creek. Pole Creek is a very inaccessible stream and is generally characterized as a deep incised canyon. Access to most segments of Pole Creek is limited, so BLM data will be used in this assessment process.

In 1999, Idaho DEQ conducted BURP monitoring on Pole Creek (BURP Site ID #1999BOIA002). The SMI score was 50.55 (condition rating “2”), but no cold water indicators were present. In 2000 and 2001, water temperature data indicated there were some periods when the water temperature exceeded the WQS criteria for CWAL and salmonid spawning. A discussion of data is located in Section 2.4. The monitoring site is located at a site known as Indian Crossing (USGS 7.5 minute quad map, Castro Table). While PCR or SCR were not assessed, it is assumed they are fully supported since no data was presented to show bacteria are violating the WQS.

The EPA does not believe that flow, or lack of flow, is a pollutant as defined by CWA Section 502(6). Since TMDLs are not required to be established for water bodies impaired by pollution (e.g., flow alteration) but not a pollutant, a flow alteration TMDL will not be written for Pole Creek.

Castle Creek (WQLS #2616)

Castle Creek does not have designated beneficial uses except for water supply, aesthetics and wildlife habitat uses (IDAPA§ 58.01.02140. 04.). There is no indication that these uses are impaired. Existing uses include CWAL, salmonid spawning and PCR or SCR. The existing uses of CWAL and salmonid spawning are based on observations made in 1999 by the BLM

(Zoellick 2001). Zoellick states redband trout were observed approximately 1.5 to 2 miles upstream from the Deep Creek confluence. The IDFG management plan includes management of the watershed for wild redband trout (IDFG 2001). The listed pollutants for Castle Creek are sediment and temperature.

Idaho DEQ had two BURP sites on Castle Creek in 1996 (BURP Site ID #1996SBOIB019 and #1996SBOIB020). The SMI scores for these sites were 34.49 and 21.58, respectively. The site with the 21.58 SMI score is upstream of the Starr Ranch area, while the lower site is located further downstream near the Castro Ranch and about 1½ miles upstream from the confluence of Deep Creek. Both SMI scores indicate CWAL is not fully supported.

Castle Creek was monitored during 2000 and 2001. The creek went dry about the end of August 2000 and about the end of July 2001. In accordance with Idaho WQS, standards apply to intermittent waters during optimum flow periods sufficient to support the uses for which the water body is designated. For recreation and water supply uses, optimum flow is equal to or greater than 5 cfs. For aquatic life uses, optimum flow is equal to or greater than 1 cfs (IDAPA§ 58.01.02.07.07).

The USGS 7.5-minute quadrangle map (Castro Table) shows that most of Castle Creek is a perennial stream. There are a few small storage impoundments in the watershed along with some spring development for livestock watering. There is also some evidence of historic irrigation water withdrawals near Starr Ranch, but it is not known if these systems are still used or if Castle Creek is a major source for irrigation water.

Biological assessment was conducted in June 2000 and again in June 2001. A continuous temperature logger was placed in Castle Creek near the confluence with Deep Creek. Temperature data indicate water temperatures exceed the WQS criteria for both CWAL and for salmonid spawning. More discussion of the data analysis is located in Section 2.4.

While PCR and SCR were not assessed during 2000 and 2001, it is assumed PCR and SCR are fully supported since no other information was provided to indicate these uses are impaired.

Battle Creek (WQLS #2621)

Battle Creek does not have designated beneficial uses except for water supply, aesthetics and wildlife habitat (IDAPA§ 58.01.02140.04.). There is no indication that these uses are impaired. Existing uses include CWAL, salmonid spawning and PCR or SCR. The IDFG management plan includes management of the watershed for wild redband trout (IDFG 2001). The segment is listed for bacteria from the headwaters to the confluence with the East Fork Owyhee River. Some diversions of Battle Creek and its smaller tributaries occur on private lands.

Bacteria samples collected at two sites on Battle Creek (Upper Crossing and Twin Bridges) showed PCR and SCR are fully supported. However, temperature data collected by the BLM in 2000 indicated exceedences of WQS. More discussion of the data analysis is located in Section 2.4.

Shoofly Creek (WQLS #2630)

Shoofly Creek does not have designated beneficial uses except for water supply, aesthetics and wildlife habitat (IDAPA§ 58.01.02140.04.). There is no indication that these uses are impaired. Beneficial uses evaluated were PCR and SCR because the listed pollutant for Shoofly Creek is bacteria. Samples collected in 2000 and 2001 showed the criteria for the support of PCR and SCR were not exceeded. More discussion of the data analysis is located in Section 2.4.

Red Canyon Creek (WQLS # 2613)

Red Canyon Creek is the only listed segment that has established designated uses (IDAPA§ 58.01.02140.04.SW-34). These uses are PCR, CWAL, water supply, aesthetics and wildlife habitat as specified in IDAPA§ 58.01.02140.04.

The existing uses of salmonid spawning and CWAL are based on research by Allen et al. (1993). They found redband trout throughout Red Canyon Creek in 1993. Densities ranged from 1.2 to 29.4 fish/100 square meters (100 m^2). The IDFG management plan includes management of the watershed for wild redband trout (IDFG 2001). IDFG has also determined that tributaries to the East Fork Owyhee River, in addition to Deep Creek and Battle Creek, should be managed for mixed species, which include redband trout. The listed pollutants of concern include sediment, temperature and flow alteration.

Red Canyon Creek was monitored in 2000 and 2001. The creek was determined to be intermittent because it was dry by the end of August 2000 and by mid-July 2001. Biological assessments were conducted in June 2000 and 2001. In accordance with the WQS, standards apply to intermittent waters during optimum flow periods sufficient to support the uses for which the water body is designated. For recreation and water supply uses, optimum flow is equal to or greater than 5 cubic feet per second (cfs). For aquatic life uses, optimum flow is equal to or greater than 1 cfs (IDAPA§ 58.01.02.07.07).

The USGS 7.5 minute quadrangle map (Red Basin) shows Red Canyon Creek as a perennial stream. There are a few small storage impoundments in the watershed along with some spring diversions for livestock watering.

In 1999, Idaho DEQ conducted BURP monitoring on Red Canyon Creek. The SMI score was 63.36, a condition rating of “3”. (BURP Site ID #1999BOIA005). There was one cold water indicator species present in the sample. The monitoring site is approximately ¼ mile downstream of the confluence of the East and West Forks of Red Canyon Creek and approximately 5 miles upstream from the confluence with the East Fork of the Owyhee River.

Limited temperature data indicated there were periods when the water temperature exceeded the WQS criteria for CWAL and salmonid spawning. Water temperature data are available for June through August 2000. A discussion of this data is located in Section 2.4. While PCR was not assessed, it is assumed to be in full support, since there was no data presented indicating bacteria levels are violating WQS.

The EPA does not believe that flow, or lack of flow, is a pollutant as defined by CWA Section 502(6). Since TMDLs are not required to be established for water bodies impaired by pollution (e.g., flow alteration) but not a pollutant, a flow alteration TMDL will not be written for Red Canyon Creek.

Nickel Creek (WQLS# 6618)

Nickel Creek does not have designated beneficial uses except for water supply, aesthetics and wildlife habitat (IDAPA§ 58.01.02140.04.). There is no indication that these uses are impaired. Existing uses include CWAL, salmonid spawning and PCR or SCR. The existing uses of CWAL and salmonid spawning are based on a BLM notation in a 1982 grazing environmental impact statement that redband trout were common to rare from the confluence with Deep Creek to near Mud Flat Road (Zoellick, 2001). The IDFG management plan includes management of the watershed for wild redband trout (IDFG 2001). Neither IDFG nor the BLM provided any fish data for the listed segment (Mud Flat Road to the headwaters). The listed pollutant is sediment. However, it should be noted that Nickel Creek is spring fed and during the past two monitoring seasons, June through August 2000 and 2001, the segment above the springs was dry. The area below the springs, approximately ¾ mile upstream from Mud Flat Road, remained flowing. The stream is diverted near Mud Flat Road to irrigate pastures and hay lands.

Data from only one BURP site is available for Nickel Creek (BURP Site #1995SBOI011). The SMI score was 9.97. This score indicates CWAL is not fully supported. Also, continuous temperature data recording showed the temperature criteria for salmonid spawning, both maximum daily and average daily temperatures, were exceeded. More discussion of the data analysis is located in Section 2.4.

2.4 Summary and Analysis of Existing Water Quality Data

Temperature Data

All temperature data are based on available temperatures taken with recording thermographs from June 2000 through September 2001. Sites were equipped with HOBO® temperature loggers. Intervals were set for readings to be taken every one hour and twelve minutes, or for 20 readings during a twenty-four hour period. Ambient air temperatures were also taken at the same intervals at three sites (Ingham 2000). Loggers were removed from ambient air sites and Red Canyon Creek (dry in 2000) to prevent damage to the loggers during the winter.

Where data are not available for June 2001 through July 2001. Data from June and July of 2000 will be used as a substitute.

Applicable Temperature Standards

As stated in the WQS, during periods when the ambient air temperature exceeds the ninetieth percentile of the seven day average daily maximum air temperature, the criteria for the support of aquatic life uses and salmonid spawning will not be applied. IDAPA§ 58.01.02.080.04 reads, “Exceeding the temperature criteria in Section 250 will not be considered a water quality standard violation when the air temperature exceeds the ninetieth percentile of the seven (7) day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station." The ambient air temperature recorded at the weather reporting station at Hollister, Idaho (Strong 2000), were used as the air temperatures for the region. Information for this weather reporting station is located at the Climatic Service Center Internet site.

For the two periods of May through September 2000 and May through September 2001, only three dates exceeded the ninetieth percentile of the seven day average daily maximum air temperature. The ninetieth percentile of the seven day average daily maximum air temperature pertaining to the Upper Owyhee Watershed is 34.3 ^{o}C (Strong 2000). Since there were so few exceedences (less than 1%), they will not be calculated into the overall data results.

Applicable Temperature Criteria

Cold Water Aquatic Life

The temperature criteria for determining compliance with WQS for the support of CWAL are located in IDAPA§ 58.01.02.250.02.b. There are two different criteria used to determine compliance with WQS. The daily maximum temperature must be no more than 22 ^{o}C, and the maximum daily average temperature must be no more than 19 ^{o}C.

Seasonal Cold Water Aquatic Life

The temperature criteria for determining compliance with WQS for the support of seasonal CWAL are located in IDAPA§ 58.01.02.250.03.b. There are two different criteria used to determine compliance with WQS. The daily maximum temperature must be no more than 26 ^{o}C, and the maximum daily average temperature must be no more than 23 ^{o}C.

Salmonid Spawning

The temperature criteria for determining compliance with WQS for the support of salmonid spawning are located in IDAPA§ 58.01.02.250.02.e.ii. There are two different criteria used to determine compliance with WQS. The daily maximum temperature must be no more than 13 ^{o}C, and the maximum daily average temperature must be no more than 9 ^{o}C. The application of WQS criteria for salmonid spawning apply to those periods during spawning and the incubation period for the particular species inhabiting those waters. The IDFG suggests that the applicable period for redband trout spawning and incubation is from about mid-March until mid-July (IDFG 2001a).

Temperature Impairment

As water temperature increases a fish's metabolic rate also increases, which then requires more oxygen intake by fish. Warmer water temperature may also cause an increase in the presence of disease-causing organisms. Fish may be more subject to these diseases during periods of stress brought on by warmer water temperature. However, the greatest temperature-caused problem for certain cold water species is the amount of dissolved oxygen (DO) within the water column. As water temperature increases the oxygen solubility decreases. This creates less available oxygen in the water.

For CWAL, the criteria for DO can be found in IDAPA§ 58.01.02.250,02.a. For salmonid spawning, the criteria can be found in IDAPA§ 58.01.02.250,02.e.i. (1)(a) and (b), and IDAPA§ §58.01.02.250,02.e.i. (2)(a).

The presence of nuisance aquatic growth brought on by an abundance of available nutrients and sunlight may also compound the situation by causing DO sags. Streams that lack adequate shading have been shown to have large mats of filamentous algae growth in the Upper Owyhee Watershed.

Data Analysis

Deep Creek

Deep Creek is by far the largest subwatershed within the Upper Owyhee Watershed. Deep Creek takes in four 5th field HUCs and encompasses an area of 274,000 acres. The main 5th field HUCs are Deep Creek, Dickshooter Creek, and Hurry Back Creek. Pole Creek makes up the other 5th field. In 2000, three temperature monitoring sites were established (Ingham 2000). Each site's data results will be discussed for 2000 and 2001.

Deep Creek (Upper)

This site is located approximately 300 meters below Mud Flat Road and approximately 400 meters below the confluence of Hurry Back Creek and Nip and Tuck Creek. These two streams form Deep Creek.

Data used in this analysis are from June 23 through August 31, 2000, and from June 1 through August 31, 2001. For the period from June 23 through August 31, 2000 maximum daily temperature criterion for the support of CWAL was exceeded on 90% of all dates. The maximum daily average temperature criterion was exceeded 86% of all dates. For salmonid spawning, the maximum daily temperature and the maximum daily average temperature criteria both were exceeded daily. Table 11 shows the statistical breakdown of results for Deep Creek at Mud Flat Road.

Table 11. Statistical Analyses of Temperature Data for Deep Creek at Mud Flat Road. Upper Owyhee Watershed.

Year and Critical Period	95th Percentile °C	Maximum °C	Minimum °C	Average °C
2000 June 23 thru August 31 Maximum Daily CWAL	26.9	27.5	16.0	24.4
2000 June 1 thru August 31 Maximum Daily Average CWAL	19.6	20.7	14.0	17.8
2000 June 23 thru July 15 Maximum Daily SS	26.3	26.3	21.7	24.2
2000 June 23 thru July 15 Maximum Daily Average SS	18.4	18.6	15.3	17.2
2001 June 1 thru August 12 Maximum Daily CWAL	25.4	26.3	13.3	21.7
2001 June 1st thru August 12 Maximum Daily Average CWAL[a]	19.2	20.4	11.1	16.6
2001 June 1 thru July 15 Maximum Daily SS[b]	25.6	26.3	13.3	21.8
2001 June 1 thru July 15 Maximum Daily Average SS	19.4	20.4	11.1	16.1

[a] Cold Water Aquatic Life, [b] Salmonid Spawning

The maximum temperature recorded during the critical period will be used to develop the TMDL (Idaho DEQ 2001). For Deep Creek near Mud Flat Road the CWAL maximum daily temperature reduction goal will be based on 27.5 °C. For the maximum daily average temperature, the reduction goal will be based on 20.7 °C. For salmonid spawning, the maximum daily temperature reduction will be based on 26.3° C and for the maximum daily average temperature, the reduction goal will be based on 20.4 °C.

Deep Creek (Middle)

This station is located 2 miles below the confluence with Pole Creek and approximately 12 miles upstream from the East Fork Owyhee River. Inaccessible canyons dominate the area upstream from this site. Temperature loggers were placed about 100 meters below the confluence with Castle Creek.

Data used in this analysis are from periods from June 23 to August 31, 2000, and from June 1 through August 31, 2001. For the period from June 23 through August 31, 2000, the maximum daily temperature criterion for the support of CWAL was exceeded on 98% of all dates. The maximum daily average temperature criterion was exceeded on 91% of all dates. For salmonid spawning, the maximum daily temperature and the maximum daily average temperature criteria both were exceeded daily. Table 12 shows the statistical breakdown of results obtained in 2000 and 2001 for Deep Creek at Castle Creek.

Table 12. Statistical Analysis of Temperature Data for Deep Creek at Castle Creek. Upper Owyhee Watershed.

Year and Critical Period	95th Percentile in °C	Maximum in °C	Minimum in °C	Average in °C
2000 June 1 thru August 31 Maximum Daily CWAL[a]	28.3	29.1	19.0	25.9
2000 June 1 thru August 31 Maximum Daily Average CWAL	23.4	24.6	16.9	21.4
2000 June 1 thru July 15 Maximum Daily SS[b]	27.9	27.9	21.7	25.8
2000 June 1 thru July 15 Maximum Daily Average SS	22.7	22.7	18.4	21.1
2001 June 1 thru August 31 Maximum Daily CWAL	27.7	28.3	16.0	24.1
2001 June 1 thru August 31 Maximum Daily Average CWAL	23.1	23.7	13.6	20.1
2001 June 1 thru June 18 Maximum Daily SS	24.0	24.0	16.0	21.1
2001 June 1 thru June 18 Maximum Average Daily SS	20.2	20.4	13.6	17.5

[a] Cold Water Aquatic Life, [b] Salmonid Spawning

The maximum temperature recorded during the critical period will be used to develop the TMDL (Idaho DEQ 2001). For Deep Creek at Castle Creek, the CWAL maximum daily temperature reduction goal will be based on 29.1 °C. For the maximum daily average temperature, the reduction goal will be based on 24.6 °C. For salmonid spawning, the maximum daily temperature reduction goal will be based on 27.9 °C, and the “maximum daily average” temperature reduction goal will be based on 22.7 °C.

Deep Creek Lower

The lower Deep Creek site is a substitute for the original site which was to be located another 5 miles downstream (Ingham 2000). The substitute site was chosen after it was determined the original site would be too resource intensive to sample and too risky to make multiple visits. Deep Creek Lower is approximately 4 miles below the Castle Creek site. The landform upstream from this site is open; downstream the stream enters into an incised canyon. This site is at the only road crossing between the East Fork Owyhee River and the Mud Flat Road.

Data used in this analysis are from periods from June to August 31, 2000, and from June 1 through August 31, 2001. For the period from June 23 through August 31, 2000, the maximum daily temperature criterion for the support of CWAL was exceeded on 85% of all dates. The maximum daily average temperature criterion was exceeded 74% of all dates. For salmonid spawning, the maximum daily and the maximum daily average temperature criteria were both exceeded daily. Table 13 shows the statistical breakdown of results obtained in 2000 and 2001 for Lower Deep Creek at Road Crossing.

Table 13. Statistical Analyses of Temperature Data for Deep Creek at Road Crossing. Upper Owyhee Watershed.

Year and Critical Period	95th Percentile °C	Maximum °C	Minimum °C	Average °C
2000 June 22 thru August 31 Maximum Daily CWAL[a]	30.3	31.1	18.7	26.9
2000 June 22 thru August 31 Maximum Daily Average CWAL	23.1	23.9	16.0	21.2
2000 June 22 thru July 15 Maximum Daily SS[b]	29.8	30.7	23.2	27.3
2000 June 22 thru July 15 Maximum Daily Average SS	23.0	23.1	18.7	21.4
2001 June 1 thru August 31 Maximum Daily CWAL	29.6	31.5	16.0	26.1
2001 June 1 thru August 31 Maximum Daily Average CWAL	22.8	23.6	14.0	19.9
2001 June 1 thru June 18 Maximum Daily SS	25.6	25.6	16.0	22.1
2001 June 1 thru June 18 Maximum Average Daily SS	20.3	20.7	14.0	17.4

[a] Cold Water Aquatic Life, [b] Salmonid Spawning

The maximum temperature recorded during the critical period will be used (Idaho DEQ 2001). For Deep Creek Lower at Road Crossing the CWAL maximum daily temperature reduction goals will be based on 31.5 °C. For the maximum daily average temperature, the reduction goal will be based on 23.9 °C. For salmonid spawning, the maximum daily temperature reduction goal will be based on 30.7 °C, and the maximum daily average temperature reduction will be based on 23.1 °C.

Pole Creek (near Mud Flat Road)

Since Pole Creek went dry in 2000 and 2001, temperature data are limited to a short period from June through August 2000 and from March through August 2001. Some data for August 2000 and August 2001 have been removed from calculation since the stream appeared to drop below the criteria for intermittent streams. For the period from June 23 through August 31, 2000 at Pole Creek near Mud Flat Road the maximum daily temperature criterion for the support of CWAL was exceeded on 90% of all dates. The maximum daily average temperature criterion was exceeded 85% of all dates. For salmonid spawning, the maximum daily temperature and the maximum daily average temperature criteria were exceeded daily for the period from June 23 through July 15.

In 2001, for the period from June 1 through August 12, the maximum daily temperature criterion for the support of CWAL was exceeded on 44% of all dates. The maximum daily average temperature criterion was exceeded 86% of all dates. For salmonid spawning, for the period from June 1 through July 15, the maximum daily temperature and the maximum daily average temperature criteria were exceeded daily. Table 14 shows the statistical analysis for Pole Creek near Mud Flat Road.

Table 14. Statistical Analyses of Temperature Data for Pole Creek near Mud Flat Road. Upper Owyhee Watershed.

Year and Critical Period	95th Percentile °C	Maximum °C	Minimum °C	Average °C
2000 June 23 thru August 31 Maximum Daily CWAL [a]	25.5	26.3	16.8	22.7
2000 June 1 thru August 31 Maximum Daily Average CWAL	22.6	23.7	13.7	20.4
2000 June 23 thru July 15 Maximum Daily SS[b]	22.8	22.9	18.7	21.1
2000 June 23 thru July 15 Maximum Daily Average SS	20.8	21.0	17.0	19.5
2001 June 1 thru August 12 Maximum Daily CWAL	24.9	25.0	17.7	21.1
2001 June 1 thru August 12 Maximum Daily Average CWAL	21.9	22.6	12.9	18.8
2001 June 1 thru July 15 Maximum Daily SS	23.7	22.0	14.5	20.5
2001 June 1 thru July 15 Maximum Daily Average SS	22.0	22.6	12.9	18.2

[a] Cold Water Aquatic Life, [b] Salmonid Spawning

The maximum temperature recorded during the critical period will be used to develop the TMDL (Idaho DEQ 2001). For Pole Creek, the CWAL maximum daily temperature reduction goal will be based on 26.3 °C. For the maximum daily average, reduction goals will be based on 23.7 °C. For salmonid spawning, the maximum daily temperature reduction goal will be based on 22.9 °C. For salmonid spawning the maximum daily average reduction goal will be based on 21 °C.

Pole Creek (near Camel Creek)

This Pole Creek site is a site where BLM collected temperature data during the summer of 2000. Data used in these analyses are for a period from July 12 through August 31, 2000. For the period from July 12 through August 31 at Pole Creek near Camel Creek the maximum daily temperature criterion for the support of CWAL was exceeded on 90% of all dates. The maximum daily average temperature criterion was exceeded on 86% of all dates. For salmonid spawning, the maximum daily temperature and the maximum daily average temperature criteria were not evaluated because the data were taken outside the spawning time frame. Table 15 shows the statistical breakdown of results obtained in 2000 for Pole Creek near Camel Creek.

Table 15. Statistical Analyses of Temperature Data for Pole Creek near Camel Creek. Upper Owyhee Watershed.

Year and Critical Period	95th Percentile °C	Maximum °C	Minimum °C	Average °C
2000 July 12 thru August 31 Maximum Daily CWAL[a]	25.6	30.1	19.1	23.8
2000 July 12 thru August 31 Maximum Daily Average CWAL	23.5	24.9	16.8	21.1

[a] Cold Water Aquatic Life

The maximum temperature recorded during the critical period will be used to develop the TMDL (Idaho DEQ 2001). For Pole Creek near Camel Creek, the CWAL maximum daily temperature reduction goals will be based on 30.1 ^{o}C. For the maximum daily average temperature the reduction goal will be based on 24.9 ^{o}C. For salmonid spawning, temperature reductions will not be established at this site due to a lack of data.

Pole Creek (upstream of Camel Creek)

This Pole Creek site is a site where BLM collected temperature data during the summer of 2000. Data used in this analysis are for a period from July 13 to August 31, 2000. For the period from July13 through August 31 at Pole Creek near Camel Creek the maximum daily temperature criterion for the support of CWAL was exceeded on 16% of all dates. The maximum daily average temperature criterion was exceeded 84% of all dates. For salmonid spawning, the maximum daily temperature and the maximum daily average temperature criteria were not evaluated because the data were taken outside the spawning time frame. Table 16 shows the statistical breakdown of results obtained in 2000.

Table 16. Statistical Analyses of Temperature Data for Pole Creek upstream of Camel Creek. Upper Owyhee Watershed.

Year and Critical Period	95^{th} Percentile ^{o}C	Maximum ^{o}C	Minimum ^{o}C	Average ^{o}C
2000 July 13 thru August 31 Maximum Daily CWAL[a]	22.7	23.2	19.4	21.2
2000 July 13 thru August 31 Maximum Daily Average CWAL	21.7	22.6	17.3	20.1

[a] Cold Water Aquatic Life

The maximum temperature recorded during the critical period will be used to develop the TMDL (Idaho DEQ 2001). For Pole Creek upstream of Camel Creek, the CWAL maximum daily temperature reduction goals will be based on 23.2 ^{o}C. For the maximum daily average temperature the reduction goal will be based on 22.5 ^{o}C. For salmonid spawning, temperature reductions will not be established at this site due to a lack of data.

Castle Creek

Since Castle Creek went dry in 2000 and 2001, temperature data are limited to a short period from June 2000 through August 2000. For the period from June 23 through August 24, 2000 the maximum daily temperature criterion for the support of CWAL was exceeded daily. The maximum daily average temperature criterion was exceeded 81% of the time. For salmonid spawning, the maximum daily temperature and the maximum daily average temperature criteria were exceeded daily from June 23 through July 15. Table 17 shows the statistical breakdown of results obtained in 2000.

Table 17. Statistical Analysis of Temperature Data for Castle Creek. Upper Owyhee Watershed.

Year and Critical Period	95th Percentile °C	Maximum °C	Minimum °C	Average °C
2000 June 23 thru August 31 Maximum Daily CWAL[a]	30.3	31.1	17.1	26.6
2000 June 23 thru August 31 Maximum Daily Average CWAL	21.1	21.4	13.3	19.4
2000 June 23 thru July 15 Maximum Daily SS[b]	30.3	31.1	22.1	27.4
2000 June 23 thru July 15 Maximum Daily Average SS	21.1	21.3	17.1	19.5

[a] Cold Water Aquatic Life, [b] Salmonid Spawning

The maximum temperature recorded during the critical period will be used to develop the TMDL (Idaho DEQ 2001). For Castle Creek, the CWAL maximum daily temperature reduction goal will be based on 30.3 °C. For the maximum daily average, reduction goals will be based on 21.1 °C. For salmonid spawning, the maximum daily temperature reduction goal will also be based on 27.4 °C. For salmonid spawning the maximum daily average reduction goal will be based on 19.5 °C.

Red Canyon Creek

Since Red Canyon Creek went dry in 2000 and 2001, temperature data are limited to a short period from June 2000 through August 2000. For the period from June 23 through August 31 the maximum daily temperature criterion for the support of CWAL was exceeded 47% of the days. The maximum daily average temperature criterion was not exceeded. For salmonid spawning, the maximum daily and the maximum daily average temperature criteria were exceeded daily for the period from June 23 through July 15. Table 18 shows the statistical breakdown of results obtained in 2000.

Table 18. Statistical Analyses of Temperature Data for Red Canyon Creek. Upper Owyhee Watershed.

Year and Critical Period	95th Percentile °C	Maximum °C	Minimum °C	Average °C
2000 June 23 thru August 31 Maximum Daily CWAL[a]	23.9	25.2	15.6	20.6
2000 June 23 thru August 31 Maximum Daily Average CWAL	17.7	18.6	14.2	15.9
2000 June 23 thru July 15 Maximum Daily SS[b]	24.3	25.2	15.6	21.0
2000 June 23 thru July 15 Maximum Daily Average SS	16.5	16.9	14.2	15.5

[a] Cold Water Aquatic Life, [b] Salmonid Spawning

The maximum temperature recorded during the critical period will be used (Idaho DEQ 2001). For Red Canyon Creek, the CWAL maximum daily temperature reduction goal will be based on 25.2 ^{o}C. For salmonid spawning, the maximum daily temperature reduction goal will also be based on 25.2 ^{o}C. For salmonid spawning the maximum daily average reduction goal will be based on 16.9 ^{o}C.

Sediment Data

Applicable Sediment Standards

The state of Idaho utilizes narrative sediment criteria and numeric turbidity criteria to determine if there are violations of WQS. Under IDAPA§ 58.01.02.200.08, "Sediment shall not exceed quantities specified in Sections 250 and 252, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Section 350."

It should be noted that with an absence of a numeric criterion for sediment, some TMDLs in Idaho have set targets for total suspended solids (TSS), suspended sediment and/or substrate embeddeness or percent fines. Once impairment to the beneficial uses has been determined, as described in IDAPA§ 58.01.02.200.08, an interpretation or an extrapolation is made with the use of literature values. These values can either define a water column allocation, substrate targets and/or both.

Section 250 of the WQS describes applicable turbidity levels. IDAPA§ 58.01.02.250.02.d. states "Turbidity, below any applicable mixing zone set by the Department, shall not exceed background turbidity by more than fifty (50) Nephelometric Turbidity Units (NTUs) instantaneously or more than twenty-five (25) NTU for more than ten (10) consecutive days."

The state WQS addresses background in IDAPA §58.01.02.003.006, which states, "The biological, chemical or physical condition of waters measured at a point immediately upstream (up-gradient) of the influence of an individual point or nonpoint source discharge. If several discharges to the water exist or if an adequate upstream point of measurement is absent, the department will determine where background conditions should be measured." With this definition in mind, the determination of background turbidity level can only be made from an area that has no anthropogenic sources that would affect water quality.

Section 252 of the WQS is the applicable standard for domestic water supply, industrial water supply and agricultural water supply. However, no numeric criteria are included to protect these uses with these uses protected under the general water quality standards (IDAPA §58.01.02.200).

Section 350 of the WQS addresses procedures to be taken if a nonpoint source is determined to be impairing beneficial uses. Section 350 also describes the State of Idaho implementation policy for addressing nonpoint sources and applicable best management practices (BMPs).

Sediment Impairments

Both suspended sediment and bedload sediment can impair beneficial uses. Suspended sediment can impair sight feeding fish by reducing their capability to find food. It may also aggravate gills and reduce oxygen intake. Bedload sediment can disturb habitat for macroinvertebrates, fill in interstitial spaces required for spawning and rearing areas, and fill in pools needed for refuge.

There are a variety of studies to determine the effects of sediment and turbidity on salmonid species. Sigler, Bjorn and Forest (1984) determined turbidity levels as low as 25 NTUs can cause a reduction in fish growth, and levels between 100-300 NTUs will cause fish to die or seek refugee in other channels. Lloyd (1987) suggested for moderate level protection of salmonid species turbidity levels up to 23 NTUs. For a high level of protection, Lloyd (1987) suggested turbidity levels up to 7 NTUs. The state of Nevada has set a numeric turbidity standard of less than or equal to 25 NTUs for the protection of aquatic life, water supply and recreational use in Lake Mead on the Nevada-Arizona border (State of Nevada NAC §445A.195).

Most studies have demonstrated that turbidity levels exceeding 25-30 NTUs will impair aquatic life use by causing reduced fish growth, reduced survival, reduced abundance, respiratory stress, and increased ventilation (Bash, Berman and Bolton 2001). Avoidance, reduced energy intake and displacement can occur at turbidity levels of 22 to greater than 200 NTUs.

Suspended sediment concentrations at levels of 100 milligrams per liter (mg/l) have shown reduced survival of juvenile rainbow trout (Herbert and Merkens 1961). The covering of spawning gravels have shown to decrease the survivability during incubation and emergence (Bash, Berman and Bolton 2001). Chronic turbidity during emergence and rearing of young anadromous salmonid could affect the quantity and quality of fish produced (Sigler et al., 1884). Sediment may also alter the hyporheic conditions, reducing ground water flows and increasing water temperature (Poole and Berman 2001).

Surface fines can impair benthic species and fisheries by limiting the interstitial space for protection and suitable substrate for nest or redd construction. Certain primary food sources for fish (Ephemeroptera, Plecoptera and Tricoptera species [EPT]) respond positively to a gravel to cobble substrate (Waters 1995). Substrate surface fine targets are difficult to establish. However, as described by Relyea, Minshall and Danehy (2000), macroinvertebrates (Plecoptera) intolerant to sediment are mostly found where substrate cover is less than 30% (<6mm). More sediment tolerant macroinvertebrates (Plecoptera) are found where the substrate cover is greater than 30% (<6mm).

Most studies have focused on smaller streams, A, B and C channel types (Rosgen 1996). Studies conducted on Rock Creek (Twin Falls County, Idaho) and Bear Valley Creek (Valley County, Idaho) found percent fines above 30% begin to impair embryo survival (Idaho DEQ 1990). Overton et al. (1995) found natural accumulation of percent fines were about 34% in C channel types. Most C channel types exhibit similar gradient as F channel types, <2.0% (Rosgen 1996).

The small mouth bass species (*Micropeterus dolomieui*), found throughout the Upper Owyhee River Watershed, require adequate substrate for nest building. This substrate could be sand or gravel (Simpson and Wallace 1982). The sucker species found in the area (*Catostomus macrohelus*) prefers gravel to rocky substrate. Northern Pikeminnow (*Ptychocheilus oregonensis*) uses streams and rivers for spawning activity, but is more of a broadcast spawner than nest builder (Simpson and Wallace 1982). Sculpin (*Cottus baird*) are also known to inhabit waters in the Upper Owyhee Watershed. Sculpin prefer clean water and clean gravel for habitat.

Salmonid species require clean, well-oxygenated gravels for spawning, incubation and emergence. Intergravel space is required for fry development, primary food source and refuge. Pools are required for mature fish development and provide areas of refugia during high water temperature, and prey protection (Burton 1991)

To determine if sediment is impairing existing beneficial uses, macroinvertebrates and periphyton samples were collected on those systems listed as being impaired by sediment. Two sets of samples were collected in 2000 and two sets in 2001.

Data Analysis

Blue Creek Reservoir

Very little information is available for Blue Creek Reservoir. However, turbidity levels did exceed accepted levels for the support of CWAL, and a TMDL will be developed to address sediment in the reservoir. Periphyton data included the presence of motile species, which indicates severe impairment from sediment. The siltation index used by the state of Montana showed poor water quality due to sediment.

Juniper Basin Reservoir

Periphyton results for Juniper Basin Reservoir indicated that sediment is a severe impairment to water quality in the reservoir. Turbidity levels did exceed accepted levels for the support of CWAL, and a TMDL will be developed to address sediment in the reservoir. However, it is not believed that an aquatic life use may be viable for the reservoir (Ingham 2001). See the discussion of existing use and beneficial use status in Section 2.3.

Deep Creek (Upper)

Allen et al. (1993) found no redband trout at any sites in Deep Creek that they evaluated. However, a high density of redband trout were found in Nip and Tuck Creek approximately 2 miles upstream of the confluence with Hurry Back Creek (Deep Creek). Idaho DEQ has not collected any fishery data through the BURP process for Deep Creek. Macroinvertebrates collected at a site near Mud Flat Road showed the expected cold water indicators were not present or the data needed verification. Periphyton analyses from samples collected in 2000 and in 2001 indicated sediment is impairing the expected algae-diatom species. The siltation index used in the state of Montana indicated that sediment is severely impairing the expected communities and the presence of motile diatom species reconfirms the impairment of coldwater indicators (Bahls 2000b and 2001a). Table 19 shows the metric analysis for samples collected in 2000 and 2001 for Upper Deep Creek.

Macroinvertebrate analysis of samples collected in 2000 showed that sediment was also impairing the expected macroinvertebrate community structure at the Upper Deep Creek site.

The presence of a Plecoptera species that is moderately tolerant to sediment, but the lack of other Plecoptera intolerant species indicated sediment is impairing the site. Table 20 shows the breakdown of results for the macroinvertebrate analysis.

Deep Creek (Middle)

Allen et al. (1993) found no redband trout at any sites in Deep Creek that they evaluated in 1993. However, a high density of redband trout were found in Nip and Tuck Creek approximately 2 miles upstream of the confluence with Hurry Back Creek (Deep Creek). Idaho DEQ has not collected any fishery data through the BURP process. There are no macroinvertebrate SMI scores available for this site since it is not an established BURP site.

Periphyton analysis from this site only indicated slight to minor impairment. The impairment is from organic loading and not associated with sediment. Reports developed by Bahls (2001*a* and 2001*b*) indicated there is some nutrient and organic enrichment at this site. Periphyton metric analyses are located in Table 19. Macroinvertebrate analyses indicate most of the EPT species found were those species that are moderately tolerant to sediment (Clark 2002). Macroinvertebrate analyses are located in Table 20.

Although there does not appear to be evidence that sediment is impairing the uses in Deep Creek near Castle Creek, there appears to be enough evidence that the system is borderline impaired from sediment. Also, with the lack of any fisheries information, including the presence or absence of salmonids and salmonid spawning, it can be extrapolated that sediment is a factor in the lack of support of CWAL in this portion of Deep Creek.

Deep Creek (Lower)

Periphyton analyses from this site only indicated slight to minor impairment. The impairment is from organic loading and not associated with sediment based on reports developed by Bahls (2001*a* and 2001*b*), which indicate there is some nutrient and organic enrichment at this site that is causing minor impairment. The periphyton metric analysis is located in Table 19.

Macroinvertebrate analyses indicated most of the EPT species found were those species that are moderately tolerant to sediment (Clark 2002). However, no Plecoptera species were found, which indicates fine sediment is impairing the uses at this site. Macroinvertebrate analysis is located in Table 20. Further available fisheries data also indicate that sediment is impairing cold water species at this site. Salmonids rely on the cold water macroinvertebrates as a main source of food.

Pole Creek

The 1995 BURP data showed an MBI of 3.22. This score indicated more evaluation of Pole Creek was required or the data needed verification. Therefore, Idaho DEQ conducted more BURP monitoring in 1999. At that time, the SMI score was 50.55 (BURP Site ID #1999BOIA002), a condition rating of 2. Percent fines showed the less than 6 mm size material covered 15% of the substrate.

The 1995 BURP data showed the less than 6 mm size material covered 21% of the substrate (BURP Site ID #1995BOIB013). Allen et al. (1993) evaluated substrate during their fish collecting effort in Owyhee County. At one site near the confluence with Deep Creek, they calculated 19% of the substrate was less than 6 mm. At another site near the confluence with Camas Creek, they calculated 55% of the substrate was less than 6 mm.

Allen et al. (1993) found no salmonid species during electrofishing. The BLM observed some redband trout at three different locations on Pole Creek in 1999, but these were thought to be fish greater than 200 mm in length. Fish sizes ranged from 200 mm to 400 mm, which would indicate the presence of two age classes. Fish under 100 mm are very difficult to observe. The 1995 BURP electrofishing effort near Indian Crossing (BURP Site #1995SBOIB014) produced no salmonid species.

Periphyton analyses of samples collected in Pole Creek in 2001 at the Indian Creek Crossing site only indicated slight impairment of beneficial uses, but the siltation index indicates that sediment is not a source of impairment to those species of soft body algae and diatom present.

Macroinvertebrates were collected in 2001 in Pole Creek. However, at the time of the development of this SBA the results from that collection effort have not been received. If the results from the 2001 collection effort indicate any conclusions other than those found previously, the SBA will be amended to show any changes in the assessment.

Biological data do not indicate sediment as a source of impairment to the existing use of CWAL. Therefore, a TMDL for sediment will not be developed. As part of the TMDL and BURP processes, water bodies will be revisited every five years and reevaluated through the reconnaissance process. If it is determined at that time that sediment levels have been increased to levels that are impairing the existing uses, then modifications to the Upper Owyhee Watershed SBA-TMDL will occur.

Castle Creek

The two sets of BURP data on Castle Creek indicated that cold water indicator species are not present in Castle Creek. With limited fisheries information, no age class determination can made in Castle Creek

Periphyton samples were collected on Castle Creek in 2000 and in 2001. The 2000 sample set includes samples for June and September. The 2001 sample set only has results for July. The results from the 2000 sampling siltation index indicate that sediment was impairing the expected algae-diatom communities in Castle Creek. The siltation index used by the state of Montana showed the presence of a large number of motile species. The presence of motile species indicates sediment and silt are impairing the expected algae-diatom diversity. The reports generated by Bahls (2001*a* and 2001*b*) also indicated slight to moderate impairment from organic loading. Table 19 shows the results from the 2000 and 2001 periphyton analysis.

Macroinvertebrate results and bioasssessment scores for Castle Creek in 2000 indicated that fine sediment is impairing the uses in the stream (Clark 2002). Both the overall taxa richness and the analysis of the orders of EPT indicated sediment is impairing the expected cold water indicators. Table 20 shows the bioassessment results for all streams.

Macroinvertebrates were collected in 2001 in Castle Creek. However, at the time of the development of this SBA the results from that collection effort have not been received. If the results from the 2001 collection effort indicate any conclusions other than those found previously, the SBA will be amended to show any changes in the assessment.

Red Canyon Creek

As mentioned in the existing beneficial use status section, Red Canyon Creek's SMI score was 63.36. There was one cold water indicator species present (BURP Site ID #1999BOIA005). Allen et al. (1993) found redband trout throughout Red Canyon Creek. Densities ranged from 1.2 to 29.4 fish/100 m^2.

Fish data collected in 1993 show a diverse age class population in the lower segment near the confluence with the East Fork Owyhee River (Allen et al. 1993). Three different lengths were recorded: less than 100 millimeters (mm), greater than 100 mm but less than 200 mm, and greater than 200 mm. With numerous young of the year (YOY) found in Red Canyon Creek a determination can made that sufficient habit is present for a self-propagating population.

Further analysis of percent fines indicates sediment is not the limiting factor for the not full support status for Red Canyon Creek. Allen et al. (1993) showed that at sites where fish surveys were conducted on average 18% of the substrate was less than 6 mm. Idaho BURP data from 1999 showed that fines of less than 6 mm were less than 5% of the substrate. Both sets of data indicate substrate fines are less than levels that would or could impair CWAL or salmonid spawning (Overton et al. 1995). With the presence of YOY salmonid species, it can be determined sediment is not a pollutant of concern.

The percent fines presented (collected at the road crossing near the confluence of the East and West Forks of Red Canyon Creek) may show some bias due to the site gradient. This site has a higher gradient than what would be found in the lower canyon segment; thus, it is probable the percent fines could be higher in the lower segment where stream gradient is lower.

Analyses of periphyton samples collected in Red Canyon Creek in 2001 indicated a slight impairment of uses, but the siltation index indicates that sediment is not the source of use impairment and expected periphyton communities are present (Bahls 2001a and 2001b). Table 19 shows the results of the 2000-2001 collection effort for all streams.

Reports developed by Bahls (2001a and 2001b) using metrics developed for the state of Montana indicate slight impairment from some nutrient enrichment. The report also noted excellent biodiversity in the periphyton community.

Macroinvertebrates were collected in 2001 from Red Canyon Creek. However, at the time of the development of this SBA the results from that collection effort have not been received. If the results from the 2001 effort indicate any conclusions other than those found previously, the SBA will be amended to show any changes in the assessment.

Biological data do not indicate sediment is a source of impairment to the existing use of CWAL. Therefore, a TMDL for sediment will not be developed. As part of the TMDL and BURP process, water bodies will be revisited every five years and reevaluated through the reconnaissance process. If it is determined at that time that sediment have increased to levels that are impairing the existing uses, then modifications to the Upper Owyhee Watershed SBA-TMDL will occur.

Nickel Creek

The only BURP data available for the Nickel Creek segment on the §303(d) list, shows expected cold water indicators are not present and there are major impairments to CWAL. There are no fisheries data for this segment and no reported fish observations below this segment. Since the temperature standard for the support of CWAL is not exceeded, it is expected there are other sources of impairment.

Periphyton analyses showed there is minor impairment, with a pollution index score also showing minor impairment. However, the siltation index indicates sediment is not a source of the impairment. Reports developed by Bahls (2001*a* and 2001*b*) stated that there maybe some organic enrichment and possible chronic metal toxicity in Nickel Creek. Another limiting factor is that the system is phosphorus limited, rather that nitrogen limited like most streams in the Upper Owyhee Watershed. Since Nickel Creek is spring feed, it would appear that phosphorus would be limited since natural bioavailable forms of phosphorus in ground waters are usually found in very low concentrations. This is further confirmed by the presence of rooted macrophytes where the only source of phosphorus is found in the sediment. Although the periphyton data indicates that sediment is not the most likely cause of impairment, the system does not have the algae-diatom species present that would indicate CWAL is supported. Further evaluation of the possible impairment causes is necessary.

Macroinvertebrate analyses showed severe impairment from sediment at this site based on very low EPT richness. In all likelihood, this impairment is due to poor substrate and habitat. The area where macroinvertebrates and periphyton samples were collected is an area of very slow flows in a wide but sometimes deep thalweg. Water velocity is not measurable in some sections. The few riffles located in this section were below the springs, and in general, the streambanks were degraded or eroding (Ingham 2001). The complicating factor of low velocity and eroding streambank will allow for any sediment that enter the system to stay in the area and not be moved through the system. This would cause embeddeness and a lack of CWAL species.

Table 19. Periphyton Results, Stream, Year, Indicator, Indices and Impairment. Upper Owyhee Watershed.

Biological Integrity Metric/ Water body	Diversity Index [a] (Shannon)	Pollution Index	Siltation Index	Disturbance Index	Number of Species Counted	Percent Dominance	Percent Abnormal
Blue Creek Reservoir							
July 2001							
Score	3.98	2.17	68.72	0.95	26	18.48	0.00
Indicator	Excellent	**Good**	**Poor**	Excellent	**Good**	Excellent	Excellent
Impairment	None	**Minor**	**Severe**	None	**Minor**	None	None
Juniper Basin Res.							
July 2001							
Score	3.25	1.47	82.51	0.99	19	35.97	0.00
Indicator	Excellent	**Poor**	**Poor**	Excellent	**Fair**	**Good**	Excellent
Impairment	None	**Severe**	**Severe**	None	**Moderate**	**Minor**	None
Deep Creek (DC-001)							
July 2000							
Score	4.44	2.39	72.60	0.59	42	16.13	0.00
Indicator	Excellent	Good	Poor	Excellent	Excellent	Excellent	Excellent
Impairment	None	**Minor**	**Severe**	None	None	None	None
Deep Creek (DC-002)							
July 2000							
Score	3.61	2.80	9.23	28.28	34	28.28	0.00
Indicator	Excellent	Excellent	Excellent	**Good**	Excellent	**Good**	Excellent
Impairment	None	None	None	**Minor**	None	**Minor**	None
Deep Creek (DC-003)							
July 2000							
Score	3.73	2.82	8.76	15.82	39	20.44	0.00
Indicator	Excellent	Excellent	Excellent	**Good**	Excellent	**Good**	Excellent
Impairment	None	None	None	**Minor**	None	**Minor**	None

Table 19. (Continued) Periphyton Results, Stream, Year, Indicator, Indices and Impairment. Upper Owyhee Watershed.

Biological Integrity Metric/ Water body	Diversity Index (Shannon)	Pollution Index	Siltation Index	Disturbance Index	Number of Species Counted	Percent Dominance	Percent Abnormal
Deep Creek (DC-001)							
Sept 2000							
Score	4.38	2.52	65.84	1.88	50	18.37	0.24
Indicator	Excellent	Good	Poor	Excellent	Excellent	Excellent	**Good**
Impairment	None	**Minor**	**Severe**	None	None	None	**Minor**
Deep Creek (DC-002)							
Sept 2000							
Score	3.65	2.66	8.49	36.00	37	36.00	0.00
Indicator	Excellent	Excellent	Excellent	**Good**	Excellent	**Good**	Excellent
Impairment	None	None	None	**Minor**	None	**Minor**	None
Deep Creek (DC-002)							
Sept 2000							
Score	2.94	2.82	2.85	36.82	24	36.82	0.00
Indicator	**Good**	Excellent	Excellent	**Good**	**Good**	**Good**	Excellent
Impairment	**Minor**	None	None	**Minor**	**Minor**	**Minor**	None
Deep Creek (DC-002)							
June 2001							
Score	3.94	2.61	23.62	6.00	38	26.32	0.00
Indicator	Excellent	Excellent	**Good**	Excellent	Excellent	**Good**	Excellent
Impairment	None	None	**Minor**	None	None	**Minor**	None
Deep Creek (DC-003)							
June 2001							
Score	4.17	2.54	30.05	3.09	40	17.10	0.00
Indicator	Excellent	Excellent	Good	Excellent	Excellent	Excellent	Excellent
Impairment	None	None	Minor	None	None	None	None

Table 19. (Continued) Periphyton Results, Stream, Year, Indicator, Indices and Impairment. Upper Owyhee Watershed.

Biological Integrity Metric/ Water body	Diversity Index (Shannon)	Pollution Index	Siltation Index	Disturbance Index	Number Of Species Counted	Percent Dominance	Percent Abnormal
Deep Creek							
July 2001							
Score	4.28	2.48	61.39	0.96	42	19.42	0.00
Indicator	Excellent	Good	Poor	Excellent	Excellent	Excellent	Excellent
Impairment	None	Minor	Severe	None	None	None	None
Deep Creek (DC-002)							
July 2001							
Score	3.22	2.63	3.84	24.01	25	24.85	0.00
Indicator	Excellent	Excellent	Excellent	Excellent	**Good**	Excellent	Excellent
Impairment	None	None	None	None	**Minor**	None	None
Deep Creek (DC-003)							
July 2001							
Score	3.40	2.59	5.22	12.69	35	28.71	0.00
Indicator	Excellent	Excellent	Excellent	Excellent	Excellent	**Good**	Excellent
Impairment	None	None	None	None	None	**Minor**	None
Pole Creek							
2001							
Score	3.36	2.23	8.51	16.89	33	25.39	0.00
Indicator	Excellent	**Good**	Excellent	Excellent	Excellent	Excellent	Excellent
Impairment	None	**Minor**	None	None	None	None	None
Castle Creek							
June 2000							
Score	4.62	2.35	43.10	3.03	48	16.22	0.00
Indicator	Excellent	**Good**	**Fair**	Excellent	Excellent	Excellent	Excellent
Impairment	None	**Minor**	**Moderate**	None	None	None	None

Table 19. (Continued) Periphyton Results, Stream, Year, Indicator, Indices and Impairment. Upper Owyhee Watershed.

Biological Integrity Metric/ Water body	Diversity Index (Shannon)	Pollution Index	Siltation Index	Disturbance Index	Number Of Species Counted	Percent Dominance	Percent Abnormal
Castle Creek							
Sept 2000							
Score	3.89	2.36	40.29	28.47	41	28.47	0.00
Indicator	Excellent	**Good**	**Fair**	Excellent	Excellent	Good	Excellent
Impairment	None	**Minor**	**Moderate**	None	None	**Minor**	None
Castle Creek							
2001							
Score	4.69	2.33	38.65	5.59	19	35.97	0.00
Indicator	Excellent	**Good**	**Good**	Excellent	**Fair**	Good	Excellent
Impairment	None	**Minor**	**Minor**	None	**Moderate**	Minor	None
Red Canyon Creek							
2001							
Score	4.10	2.34	18.64	18.27	41	19.14	0.00
Indicator	Excellent	Good	Excellent	Excellent	Excellent	Excellent	Excellent
Impairment	None	Minor	None	None	None	None	None

Table 20. Macroinvertebrate Data Analysis. Taxa Richness, EPT Assessment and Bioassessment Scores. Upper Owyhee Watershed.

Stream	Date	Taxa Richness	EPT Richness	Ephemeroptera Richness	Plecoptera Richness	Tricoptera Richness	Mean Bioassessment Score (n)[a]
Deep Cr-002	June 2000	49	16	8	0	8	4.4 (11)
	August 2000	47	16	8	1	7	4.4 (11)
Deep Cr-003	June 2000	50	11	5	1	5	4 (12)
Deep Cr-003	June 2000	47	13	8	0	5	4.8 (10)
	August 2000	37	09	3	0	6	3.4 (7)
Castle Creek	June 2000	39	14	8	1	5	4.1 (13)
	August 2000	29	06	3	0	3	4.0 (5)
Nickel Creek	June 2000	27	03	2	0	1	4.4 (5)
	August 2000	32	03	0	0	3	5.0 (3)

a Although all the data is important to show biodiversity for macroinvertebrates, the bioassessemt score indicates the species found are moderately tolerant to fine sediment. Studies cited in Clark (2002) show these species are found in streams where fine sediment (<6 mm) cover between 50-70% of the substrate (Relyea et al. 2000).

<u>Bacteria Data</u>

Applicable Bacteria Standards

In 2000, the state of Idaho adopted *E. coli* as the standard to determine if recreational uses are supported in the waters of the state. Past monitoring used fecal coliform as an indicator for the support or non-support of recreational uses. It was the use of fecal coliform data that Battle Creek and Shoofly Creek on the 1998 §303(d) list based on one time high readings that exceeded the past criteria for the support of either PCR or SCR. Studies have shown the use of fecal coliform bacteria may not have been the best indicator of bacteria or the presence of fecal type material. The current indicator bacteria, *E. coli*, are a better indicator of fecal type contamination and the presence of other bacteria that may pose a risk to public health.

The current criteria for determining if PCR or SCR uses are supported are found in IDAPA§ 58.01.02.251.01 and 02. The criteria are based on a one time sampling event, and/or a five sample set collected over a 30 day period to obtain a geometric mean. The WQS for the support of primary contact recreation states, **" Primary Contact Recreation"**. Waters designated for primary contact recreation are not to contain *E.coli* bacteria significant to the public health in concentrations exceeding:

a. For areas within waters designated for primary contact recreation that are additionally specified as public swimming beaches, a single sample of two hundred thirty-five (235) *E. coli* organisms per one hundred (100) ml. For the purpose of this subsection, "specified public swimming beaches" are considered to be indicated by features such as signs, swimming docks, diving boards, slides, or the like, boater exclusion zones, map legends, collection of a fee for beach use, or any other unambiguous invitation to public swimming. Privately owned swimming docks or the like which are not open to the general public are not included in this definition.

b. For all other waters designated for primary contact recreation, a single sample of four hundred six (406) *E.coli* organisms per one hundred (100) ml; or

c. A geometric mean of one hundred twenty-six (126) *E.coli* organisms per one hundred (100) mlbased on a minimum of five (5) samples taken every three (3) to five (5) days over a thirty (30) day period."

The WQS for the support of secondary contact recreation states, **"Secondary Contact Recreation"**. Waters designated for secondary contact recreation are not to contain *E.coli* bacteria significant to the public health in concentrations exceeding:

a. A single sample of five hundred seventy-six (576) *E.coli* organisms per one hundred (100) ml; or

b. A geometric mean of one hundred twenty-six (126) *E.coli* organisms per one hundred (100) ml based on a minimum of five (5) samples taken every three (3) to five (5) days over a thirty (30) day period.

Bacteria Impairments

E. coli is itself a pathogen and has been associated with a variety of gastrointestinal diseases. It may also indicate the presence of other waterborne diseases associated with viruses, protozoa or other bacteria. Some virus-associated diseases include hepatitis A and rotavirus. Diseases associated with protozoa include cryptosporidiosis and giardiasis. Waterborne bacterial diseases include typhoid fever and cholera.

Data Analysis

Battle Creek

The remoteness of access sites on Battle Creek greatly hampered the ability to gather samples in 2000 and 2001. Samples were collected at three sites in 2001. All samples were below the WQS criteria for the support of PCR and SCR. The results of the three (3) samples are shown in Table 21. Idaho DEQ will remove bacteria as a pollutant in Battle Creek on Idaho's 2002 §303(d) list.

Table 21. Bacteria Monitoring Results for Battle Creek, 2001. Upper Owyhee Watershed.

Station	Date	*E. coli* Number/100 ml
Battle Creek downstream of Big Spring Creek	July 10, 2001	12
Battle Creek upstream of Big Spring Creek	July 10, 2001	27
Battle Creek at Upper Crossing	July 10, 2001	90

Shoofly Creek

Two sampling sites were selected on Shoofly Creek in 2000. Since Shoofly Creek went dry upstream of Bybee Reservoir early in the season, it was not possible to get samples upstream. Samples were collected below Bybee Reservoir and both samples were below the WQS criteria for the support of PCR and SCR. Idaho DEQ will remove bacteria as a pollutant in Shoofly Creek on the 2002 Idaho §303(d) list. Table 22 shows the bacteria results for Shoofly Creek for 2000.

Table 22. Bacteria Results for Shoofly Creek, 2000. Upper Owyhee Watershed.

Station	Date	*E. coli* Number/100 ml
Shoofly Creek at Road Crossing	August 15, 2000	<1
Shoofly Creek below Bybee Reservoir	August 15, 2000	50

2.5 Data Gaps

The Upper Owyhee Watershed is a very remote area. From Boise, Idaho, it can take up to five hours to reach some monitoring sites. The sheer size of the watershed (over 1,000,000 acres), inaccessible areas and few roads are enough to hamper any scientific evaluation. None of the streams are land accessible during winter months or during periods of snowmelt. Even with a great deal of time invested evaluating streams, further evaluation could have enhanced the development of the Upper Owyhee Watershed SBA-TMDL.

Beneficial Use Status

Many of the water bodies listed on the §303(d) list for the Upper Owyhee Watershed are very remote, with many segments in areas not accessible by vehicles. These areas are in steep incised canyons that do not have access except for from an up or down stream location. More biological information (fish, macroinvertebrates, periphyton, etc.) would provide an overview of areas where current land use practices may or may not be impairing beneficial uses.

Temperature

Ideally more water temperature data should be collected on all systems within the Upper Owyhee Watershed, including listed and non-listed streams. Temperature data should be collected for a longer period and should take in periods when normal snowpack and precipitation events are occurring. Temperature monitoring on different segments (locations) of streams that were monitored would provide additional valuable data and would assist in water temperature model validation.

An analysis of the ground water influences in the Upper Owyhee Watershed would be extremely valuable. As described in the pollution source analysis, ground water may have a major impact in reducing surface water temperature. More information on the site potential for riparian vegetation is also lacking.

Sediment

With the large number of streams on the §303(d) list for sediment impairment, it was not possible to obtain the data to complete an accurate evaluation within the available time. The remoteness of the area and the inability to conduct year round water quality monitoring also hampered Idaho DEQ's ability to compare instream water quality (turbidity and suspended sediment) to the WQS.

Ideally, more stream embeddeness and percent fines surveys should be completed. These are very time consuming and resource intensive analyses. The streambed data presented in this document is limited to areas that are easily accessible.

Turbidity source analysis is identified as another data gap. It was not evaluated if the turbidity issues in the two reservoirs (Juniper Basin and Blue Creek) are an internal source or if the source is associated with activity in the watershed. Further analysis of the two watersheds will need to be completed along with a more in-depth analysis of reservoir management.

Hydrology

Historic stream flow measurements are nonexistent in the Upper Owyhee Watershed. It is recognized that the Owyhee Watershed is an arid area where frequent and sometime heavy precipitation events can affect the hydrology of the watersheds. Without historic or even current flow information, it is difficult to determine an accurate loading analysis or apply accurate and applicable WQS to certain segments (i.e. intermittent waters).

With the absence of flow data, "*Estimating Monthly and Annual Streamflow Statistics at Ungaged Sites in Idaho*" (Hortness and Berenbrock 2000) was used to determine discharge from selected watersheds (i.e. flow prediction models). This model was the only resource available to estimate flows in this region.

2.6 Non-Listed Water Quality Limited Segments and/or Additional Pollutant(s) of Concern

Battle Creek

Battle Creek was listed for impairment of recreational uses associated with bacteria. However, data obtained from the BLM for temperature indicated WQS were exceeded for the support of CWAL. The IDFG management plan includes management of the watershed for wild redband trout (IDFG 2001). Table 23 shows the statistical breakdown for temperature monitoring conducted by the BLM.

Table 23. Battle Creek Temperature Results, 1999 and 2000. Upper Owyhee Watershed.

Year and Critical Period	95th Percentile °C	Maximum °C	Minimum °C	Average °C
Battle Creek at Twin Bridges				
1999 July 14 thru August 31 Maximum Daily CWAL[a]	24.86	25.10	17.62	23.01
1999 July 14 thru August 31 Max. Daily Average CWAL	20.47	21.45	13.56	18.82
2000 July 7 thru August 31 Maximum Daily CWAL	27.83	30.16	18.49	24.90
2000 July 7 thru August 31 Max. Daily Average CWAL	21.44	21.97	15.76	19.60
Battle Creek at Upper Crossing				
1999 July 14 thru August 31 Maximum Daily CWAL	25.22	25.29	16.52	22.88
1999 July 14 thru August 31 Max. Daily Average CWAL	20.89	22.26	13.67	19.09

[a] Cold Water Aquatic Life

In 1999, at the upper road crossing site, the CWAL criterion for maximum daily temperature was exceeded 71% of all dates. The CWAL criterion for maximum daily average temperature was exceeded on 61% of all dates. For the Twin Bridges site, in 1999 the CWAL criterion for maximum daily temperature was exceeded on 84% of all dates. The CWAL criterion for maximum daily average temperature was exceeded on 51% of all dates. In 2000, at the Twin Bridge site, the CWAL criterion for maximum daily temperature was exceeded on 94% of all dates. The CWAL criterion for maximum daily average temperature was exceeded on 63% of all dates. A temperature TMDL will not be developed for Battle Creek at this time, but Idaho DEQ will place it on the next §303(d) list.

Nickel Creek

Nickel Creek is not listed for temperature. However, a Hobo® Temperature logger was placed in Nickel Creek with the idea it may be a possible reference site. During July through August 2000, the CWAL criteria were not exceeded. However, both temperature criteria for salmonid spawning were exceeded during June 1 through June 20, 2001. The 13 ^{o}C criterion was exceeded on 75% of the 20 dates with results. The 9 ^{o}C criterion was exceeded on 100% of the same dates. Due to operator error, the remainder of the salmonid spawning season cannot be evaluated.

A TMDL for temperature will not be developed at this time due to the minimal amount of data available. Idaho DEQ will list temperature as a pollutant of concern for Nickel Creek on the next Idaho §303(d) list.

Camas Creek

Camas Creek is a 3rd order tributary to Pole Creek. Through the assessment process of the Upper Owyhee Watershed the BLM has provided temperature data for the stream. This data showed 22% of the data from July 13th through August 31, 2000, exceeded the daily average temperature for the protection of CWAL. The IDFG management plan includes management of the watershed for wild redband trout (IDFG 2001). A TMDL for temperature will not be developed for Camas Creek at this time, but it will be added as a water quality limited segment on the next Idaho §303(d) list.

Additionally, the assessment process for the Water Body Assessment Guidance (Idaho DEQ 2002) showed the overall SMIs and SHIs scores indicated that CWAL is not full support. It is recommended a TMDL not be developed for Camas Creek at this time. However, the temperature loading analysis for Camas Creek as presented in Section 5.0 could be utilized as the basic framework for analysis. Additional information is required to determine possible other pollutants of concern. Camas Creek will be added as a Water Quality Limited Segment on the next Idaho DEQ §303(d) list.

Deep Creek

During the 2000 monitoring effort, large areas of filamentous algae were present within Deep Creek. With this in mind, further investigation of dissolved oxygen (DO) levels within the water column were needed. Instantaneous DO measurements showed DO sags occurring after sunset, even though temperatures dropped during the same period. In July 2001, 24-hour temperature / DO monitoring was conducted. The results are shown in Figure 10.

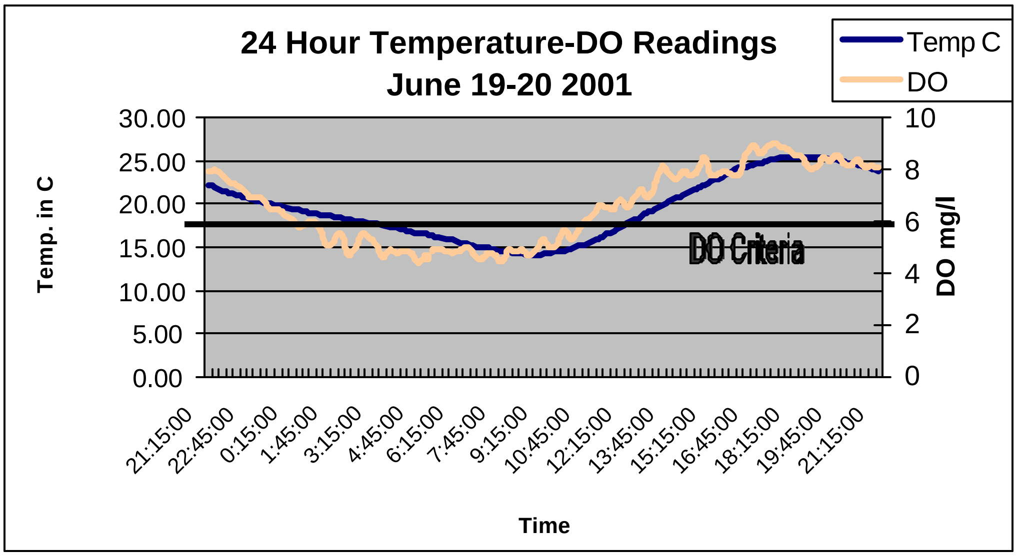


Figure 10. Twenty-four Hour Temperature Dissolved Oxygen Results, Deep Creek June 19-20, 2001. Upper Owyhee Watershed.

These results showed DO sags possibly associated with nuisance aquatic growth. That is, since water temperature was dropping at the same time, water column DO levels should have been rising. Since DO levels sagged during the period of respiration and once again raised during periods of photosynthesis, it is possible that algae growth was affecting water column DO levels. Water column monitoring did not indicate the presence of nutrients at levels that would usually cause nuisance aquatic growth. Further analysis of algae species would be beneficial in determining the nutrient fixing capability of the algae. However, since other indicators of respiration and photosynthesis (such as carbon and pH) were not evaluated, a TMDL will not be written to address DO at this time. Idaho DEQ will add DO as beneficial use impairment for the next cycle of the Idaho §303(d) list.

Camel Creek

Camel Creek is a 3rd order tributary to Pole Creek. The assessment process for the Water Body Assessment Guidance (Idaho DEQ 2002) showed the overall SMIs and SHIs scores for Camel Creek indicated that CWAL is not full support. It is recommended a TMDL not be developed for Camel Creek at this time.

Although there is indication that temperature is a pollutant of concern, there may be other pollutants impairing the beneficial uses. However, the temperature loading analysis for Camas

Creek as presented in Section 5.0 could be utilized as the basic framework for analysis. Additional information is required to determine possible pollutants of concern. Camel Creek will be added as a Water Quality Limited Segment on the next Idaho DEQ §303(d) list.

Beaver Creek

Beaver Creek is a 3rd Order stream that enters Deep Creek near the confluence with the East Fork of the Owyhee River. Beaver Creek originates on the eastside of Juniper Mountain and flows generally west to east. The assessment process for the Water Body Assessment Guidance (DEQ 2002) showed the overall SMIs and SHIs scores for Beaver Creek indicated that CWAL is not full support. It is recommended a TMDL not be developed for Beaver Creek at this time.

Although there is indication that temperature is a pollutant of concern, there may be other pollutants impairing the beneficial uses. However, the temperature loading analysis for Beaver Creek as presented in Section 5.0 could be utilized as the basic framework for analysis. Additional information is required to determine possible other pollutants of concern. Beaver Creek will be added as a Water Quality Limited Segment on the next Idaho DEQ §303(d) list.

Dry Creek

Dry Creek is a 2nd Order stream that flows into Battle Creek from the west. The headwaters originate from the Owyhee Mountains and the Antelope Flats area. The assessment process for the Water Body Assessment Guidance (Idaho DEQ 2002) showed the overall SMIs and SHIs scores for Dry Creek indicated that CWAL is not full support. A TMDL will not be developed for Dry Creek at this time. Dry Creek will be placed on the next §303(d) list as a Water Quality Limited Segment. Pollutant(s) of concern are not known at this time. Existing beneficial uses are also unknown. However, the IDFG management plan includes management of the watershed for wild redband trout (IDFG 2001).

Nickel Creek (Salmonid Spawning Temperature and Metals)

Nickel Creek is not listed for temperature. However, a Hobo® Temperature logger was placed in Nickel Creek with the idea it may be a possible reference site. During the period from July through August of 2000 the CWAL criteria were not exceeded. During the spring of 2001, June 1 through June 20, both temperature criteria for salmonid spawning were exceeded. The 13^{o}C criterion was exceeded on 75% of the twenty dates with results. The 9^{o}C criterion was exceeded on 100% of the same dates. Due to operator error, the remainder of the salmonid spawning season cannot be evaluated. A TMDL for temperature will not be developed at this time due to the minimal amount of data available. Idaho DEQ will list temperature as a pollutant of concern for Nickel Creek on the next Idaho DEQ §303(d) list. However, the temperature loading analysis for Nickel Creek as presented in Section 5.0 could be utilized as the basic framework for analysis.

Periphyton data and interpretation of that data indicated that there may be a chronic toxic metal issue in Nickel Creek. Since this was not a pollutant of concern on the 1998 §303(d) list, it was not a parameter that was monitored for. It is recommended that metal be placed as pollutant of concern for the next cycle for the §303(d) listing process. It is currently felt that there is not enough information to proceed with a TMDL to address metals as a pollutant of concern and develop a TMDL.

Recommendations

Table 24 is a list of actions that will occur on Water Quality Limited segments in the Upper Owyhee Watershed (HUC 17050104).

Table 24. Action Items for Water Quality Limited Segments. Upper Owyhee Watershed.

Stream Name	Action for TMDL and Next Idaho §303(d) list	Pollutant(s) of Concern For TMDL and/or Future Listing	Uses Impaired
Blue Creek Reservoir	Develop TMDL	Sediment	CWAL[c], SS[d]
Juniper Basin Reservoir	UAA[a] & Propose Modified Aquatic Life Use	Sediment	NA
Deep Creek	Develop TMDL, List for DO[b]	Temperature, Sediment, Organic Enrichment, DO	CWAL, SS
Pole Creek	Develop TMDL	Temperature	CWAL, SS
Castle Creek	Develop TMDL	Temperature, Sediment	CWAL, SS
Red Canyon Creek	Develop TMDL	Temperature	CWAL, SS
Nickel Creek	Develop TMDL, List for Temperature and Metals	Sediment, Temperature and Metals	CWAL, SS
Battle Creek	De-List for Bacteria, List for Temperature	Temperature	CWAL, SS
Shoofly Creek	De-List for Bacteria, De-List as Impaired Water Body	NA	NA
Camas Creek	List on Next §303(d) list	Temperature	CWAL, SS
Camel Creek	List on Next §303(d) list	As per the WBAG II	Unknown
Beaver Creek	List on Next §303(d) list	As per the WBAG II	Unknown
Dry Creek	List on Next §303(d) list	As per the WBAG II	Unknown

Use Atainabiltity Analysis, b. Dissolved Oxygen, c. Cold Water Aquatic Life, d. Salmonid Spawning

Table 25 lists recommended designated beneficial uses to be placed in IDAPA§ 58.02.01.140 for the Upper Owyhee Watershed.

Table 25. Recommendation of Designated Beneficial Uses. Upper Owyhee Watershed.

Stream Name	Recommendation for Designated Uses
Blue Creek Reservoir	CWAL[a], PCR[b]
Juniper Basin	Modified Aquatic Life Use, PCR
Deep Creek	CWAL, SS[c], PCR
Pole Creek	CWAL, SS, PCR
Castle Creek	CWAL, SS, PCR
Red Canyon Creek	Established Designated Uses and SS
Nickel Creek	CWAL, SS, PCR
Battle Creek	CWAL, SS, PCR
Shoofly Creek	CWAL, SS, PCR

a.Cold Water Aquatic Life, b. Primary Contact Recreation, c. Salmonid Spawning

3. Subbasin Assessment – Pollutant Source Inventory

3.1 Point Sources

There are no point source discharges in the Upper Owyhee Watershed.

3.2 Nonpoint Sources

Temperature

There are many natural factors that can affect water temperature. These natural factors are known as drivers, which may include topographic shading, upland vegetation, precipitation, air temperature, wind speed, solar angle cloud cover, relative humidity, phreatic ground water temperature and discharge, and tributary temperature and flow (Poole and Berman 2000). It is when the influence of anthropogenic sources alters the ecological drivers and other physical characteristic that an out-of-balance heat exchange can occur.

Some of the physical factors affecting the drivers in the Upper Owyhee Watershed may include removal of adequate stream cover (riparian vegetation), upland vegetation changes (ground water infiltration) and stream morphology degradation (increased width-depth ratio, floodplain access). Along with physical factors, there are climatic factors that should be considered, such as snowmelt, ambient air temperature and precipitation. During 2000 and 2001 precipitation for the Upper Owyhee Watershed was below normal, both in yearly snowpack and summertime precipitation. These climatic conditions can alter the amount of flow, which will affect water temperature (Poole and Berman 2000).

High water temperatures in the Upper Owyhee Watershed appear to be associated with solar radiation, ambient air temperature and lack of ground water influence. All can have a direct or indirect effect on water temperature and can be influenced by a variety of physical attributes and stream-riparian conditions.

Solar radiation is the direct impact of solar energy on water. Different conditions can alter the amount of solar radiation reaching the water surface or the amount of water surface available to solar radiation. Reducing shading or stream cover has been shown to increase the water temperature (Teti 1998). Brown (1970) showed solar radiation on water surfaces was the greatest factor in high water temperature during critical summertime periods. The other physical characteristic affecting solar radiation is the amount of surface area exposed. A wide shallow stream allows for more surface area to be affected by solar radiation (width-depth ratio).

Lack of adequate stream (canopy) cover can affect the heat transfer from water to air. Stream cover provides a buffering capability for the interaction between water surface and the ambient air by reducing wind speed over water surface. It can also affect the relative humidity near the water surface, which affects the degree of heat transfer. Water evaporation rates increase when there is greater wind speed and solar radiation. This condition will reduce the amount of available water within the stream channel.

Ground water influences have been altered in many of the C channel type streams in the Upper Owyhee Watershed. These stream types are usually associated with low gradient (<2%) wet meadow type hydrologic conditions. As many of these systems down-cut into finer course material, ground water levels in the adjacent areas lower dramatically. In some areas these down-cuts have deepened the stream channel 3-6 meters below what was once the historic stream elevation. Old stream channels are evident in many of the low gradient stream areas. With the downcutting into these systems, there is a loss of the ability of the stream to have access to the historic floodplain and the ground water storage these systems are capable of achieving (Thomas et al. 1998). As these areas down-cut, ground water also retreated to a base flow and was greatly reduced once the stream hit a less erodible material, such as bedrock or hardpan. With this natural geological material, ground water storage is inadequate to provide crucial recharge during summertime flows, altering both the flow and water temperature.

Another factor to be considered is the effect on the hyporheic flow condition (below streambed flow). The hyporheic flow relies on the ability of streams to form pools and riffles, and the near benthic area of the stream to cool water for surface water. As water enters a pool or a meander, there is a natural driver for surface water to be forced into the ground. Ground water will follow gravity and flow downstream and reenter the stream at a lower or equal elevation from which it entered. As the ground water passes through alluvial soils, it is cooled to the ambient soil temperature (Wroblicky et al. 1996; Stanford, Ward and Ellis 1994).

As many of the streams in the Upper Owyhee Watershed down-cut, the natural capability to form meanders and adequate riffle-pool ratio diminishes. This indicates these streams have also lost the natural hyporheic flow driver for water temperature buffering. Stream sinuosity and the presence of geomorphic features are other factors in stream and hyporheic flow conditions. The lack of an adequate floodplain, side channels and backwaters are critical influences for hyporheic flows and water temperature (Poole and Berman 2000).

As described by Dupont (1999*a*), the current down-cutting of the streams in the North and Middle Fork Owyhee Watersheds is probably not entirely associated with current land use practices, but with the removal of beavers from the area (Idaho DEQ 1999*c*). The removal of beavers and the lack of maintenance of their dams allowed streams to down-cut into the course material that were, at one time, held back by beaver activity. This is also true for those streams in the Upper Owyhee Watershed.

This downcutting occurred until the stream met a more stable substrate (i.e., bedrock, hardpan), then stabilized. Under natural conditions, the stream will slowly regain access to the historic floodplain, building back up through the deposition of fine material during high flows. The presence of adequate vegetation is critical during this process for reducing stream velocity and providing streambank protection (Thomas et al. 1998).

Sediment

Sediment sources in the Upper Owyhee Watershed can vary from streambank erosion, overland flow, wind blown deposition, and instream channel transport. There is little information on any sources that can provide a quantitative estimate of the delivery rate to streams showing sediment is impairing the existing uses. However, studies have shown a direct impairment of aquatic biota communities and sediment from associated land use practices (Strand and Merritt 1999).

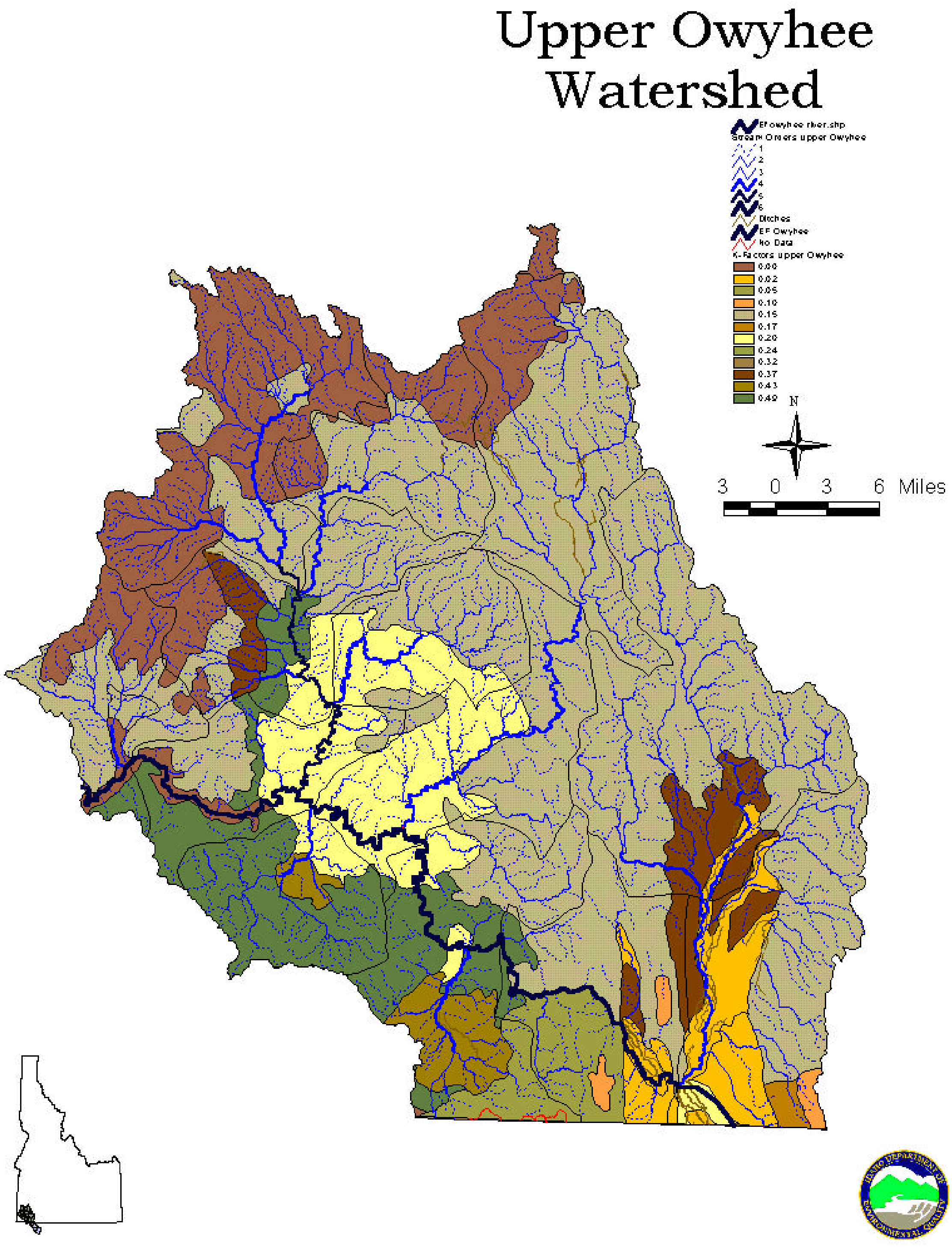
Overland flow usually consists of gully erosion, mass wasting and general surface erosion. Since there is a certain amount of overland flow sediment that gets tied up in hillside storage, it is very difficult to determine the exact delivery rate to water bodies from this source. The Natural Resources Conservation Service (NRCS) has determined the erosion factors for many areas in Owyhee County, including the Upper Owyhee Watershed. One factor in determining erosion is the K-Factor, or the measure of soil erodibility as affected by intrinsic soil properties (National Sedimentation Laboratory 2002). Along with other factors such as slope, slope length, cover and erosivity of the climate, a determination of average annual soil loss can be determined based on tons/acre/year.

Low K values, (0.05-0.15) where soils are mostly high in clay content and are more resistant to detachment, are typically the least erodible. Silt-loam soils are more easily detached and have a K value of greater than 0.4. Table 26 shows the percent and total number of acres that demonstrate certain K values in the Upper Owyhee Watershed. Figure 11 shows a schematic of K-Values in the watershed.

Table 26. K Values and Acreage Percent. Upper Owyhee Watershed.

K-Value Factor*	Erodibility	Acres*	Percent*
0.0	Low	157,628	14.8%
0.02	Low	43,143	4.1%
0.05	Low	32,971	3.1%
0.1	Low	7,100	0.7%
0.15	Low	498,904	46.9%
0.17	Medium	3,081	0.3%
0.2	Medium	105,051	9.9%
0.24	Medium	4,642	0.4%
0.32	Medium	20,742	1.9%
0.37	Medium	42,598	4.0%
0.42	High	49,645	4.7%
0.49	High	99,222	9.3%
Total		1,064,727	100%

aData obtained from USDepartment of Agriculture –Natural Resource Conservation Service STATSGO database. Some acreage are within Nevada and not delinated.



Data obtained from USDA-NRCS STATSGO database.

Figure 11. Erosion K-Factors. Upper Owyhee Watershed.

Slope of the land and other variables such as precipitation, wind erosion, the erosion potential of soils and other natural factors can also affect overland erosion. In the case of the Upper Owyhee Watershed, slope does not appear to be a critical factor in overland erosion. Table 27 shows percent slopes acreage within the Upper Owyhee Watershed along with the percentage the slope covers in the watershed. The percent slope was obtained from the weighted average per the map unit ID obtained from state soil geographic database (STATSGO). The table represents an overall average for the area.

Table 27. Slope, Acreage[a] and Percent. Upper Owyhee Watershed.

Slope (%)	<5%	> 5% and <10%	>10% and <15%	>15% and <20%	> 20% and <25%	>25%	Total
Acreage	49,747	198,815	8,995	736,655	5,909	11,982	1,012,103
% of Total	4.9%	18.6%	0.9%	72.8%	0.6%	11.8%	109.60%

aTotal acres from K Factor values differ due to calculation factors of GIS-STATGO layers.

The Owyhee Resource Management Plan (ORMP) (BLM 1999) identified those areas with a slope exceeding 30%, a K-Factor value of greater than 0.43 and wind erodible group (WEG) value of less than 4 as critical areas for high soil erosion. Less than 1% of the land in the Upper Owyhee Watershed had a WEG of less than 4. The ORMP does not provide much detail on the overall critical areas for high soil erosion areas within the Upper Owyhee Watershed, but does identify areas within some land use areas where current practices have high soil erosion potential within in the BLM management area. Since the Upper Owyhee Watershed takes in a small percentage of the area addressed in the ORMP (east of Deep Creek) the critical soil erosion areas appear, but are much less frequent in the remainder of the Upper Owyhee Watershed.

Smaller subwatersheds (1st and 2nd order streams) provide some sediment load to the larger streams that are listed for sediment as a pollutant of concern. However, since many of these smaller watersheds only provide sediment input during snowmelt and storm events, it is very difficult to determine actual sediment loads from these subwatersheds.

Review of aerial or LANSTATS photos do not indicate that mass wasting or roads are critical factors or sources of sediment in the Upper Owyhee Watershed. The road density in the watershed is so low that the use of current Geographical Information System (GIS) databases cannot determine density.

Although not easily quantified, streambank erosion can be significant source of sediment. As seen in Figures 12 and 13, sediment from streambank erosion provides a continuous source of sediment.

Figure 12. Deep Creek near Mud Flat Road. Upper Owyhee Watershed.

Figure 13. Deep Creek near Castle Creek Confluence. Upper Owyhee Watershed.

Stream geomorphology changes associated with beaver removal started in the late 1700s and early 1800s. The removal of the beaver population probably continued until the area was depleted or was no longer profitable. Even in the early 1900s the state of Idaho noted the depleted beaver population and prohibited the taking of beavers until 1957 (Platts and Onishuk 1988). In the early 1860s, a more extensive and permanent presence of man is documented, along with the current land use practices. As described earlier, the riparian areas were the most productive lands and were used for farming and ranching (Adams 1986).

The use of the vegetation along riparian corridors can be directly related to streambank erosion (Mosely et al. 1997, Platts and Nelson 1985, Platts 1979). This is especially evident in old C channel (Figure 14) types or in wet meadows where downcutting has occurred and access to the historic floodplain has been lost. Figure 15 shows the development of a “nick point” upstream of a down-cut area on Castle Creek.

Measurement of streambank erosion is easily quantifiable with direct evaluation of critical areas. Goals and objectives can be set that reflect conditions for reduction of sediment loads on those streams showing impairment from sediment.

Figure 14. Pole Creek near Mud Flat Road. Upper Owyhee Watershed.

In-channel storage and transport of sediment is a naturally occurring process. It is when the sediment load is out of balance with the natural sediment load balance, that impairment happens to the natural hydrology functions. It should be noted that the Upper Owyhee Watershed is a semi-arid climate and heavy, but brief precipitation events take place. However, with the removal of vegetation along stream riparian areas, these events have a detrimental effect and can exacerbate streambank erosion.

In-stream sediment can be measured a variety of ways: percent fines, pool volume, thalweg profile and cobble embeddeness.

Figure 15. Nick-point on Castle Creek. Upper Owyhee Watershed.

4. Subbasin Assessment – Summary of Past, Present and Implementation Strategy for Pollution Control Efforts

4.1 Point Sources

There are no point sources in the Upper Owyhee Watershed.

4.2 Nonpoint Sources

The state has responsibility under Sections 401, 402 and 404 of the CWA to provide water quality certification. Under this authority, the state reviews dredge and fill, stream channel alteration and National Pollutant Discharge Elimination System (NPDES) permits to ensure the proposed actions will meet the state of Idaho WQS.

Under Section 319 of the CWA, each state is required to develop and submit a nonpoint source management plan (NSMP). Idaho's NSMP has been submitted to the EPA and has been approved (Idaho DEQ 1999*b*). The NSMP identifies programs for implementation of BMPs, identifies available funding sources and includes a schedule for program milestones. It is certified by the state of Idaho Attorney General to ensure adequate authorities exist to implement the NSMP.

Idaho's NSMP describes many of the voluntary and regulatory approaches the state will take to abate nonpoint source pollution. Section 39-3601, et seq., includes provisions for public involvement, such as the formation of Basin Advisory Groups (BAG) and Watershed Advisory Groups (WAG) (IDAPA§ 58.01.02.052). The WAGs are established in high priority watersheds to assist Idaho DEQ and other state agencies in formulating specific actions needed to control point and nonpoint sources of pollution affecting water quality limited segments. A WAG was formed to assist with the *North and Middle Fork Owyhee Subbasin Assessment and Total Maximum Daily Load* (Idaho DEQ 1999*c*) and implementation plan. It is proposed this WAG be used as the main stakeholder contact for the Upper Owyhee Watershed TMDL and its implementation plan. This implementation plan must be completed within 18 months after approval of the TMDL.

The state of Idaho uses a voluntary approach to control agricultural nonpoint sources. However, regulatory authority can be found in the WQS (IDAPA§ 58.01.02.350.01 through 58.01.02.350.03). IDAPA§ 58.01.02.054.07 refers to the Idaho Agricultural Pollution Abatement Plan (Ag Plan) which provides direction to the agricultural community-approved BMPs (IDA-SCC 1993). A portion of the Ag Plan outlines responsible agencies or elected groups (Soil Conservation Districts [SCDs]) who will take the lead if nonpoint source pollution problems need to be addressed. For agriculture, it assigns the local SCDs to assist the land owner/operator with developing and implementing BMPs to abate nonpoint source pollution associated with the land use. If a voluntary approach does not succeed in abating the pollutant problem, the state may seek injunctive relief for those situations that may be determined to be an imminent and substantial danger to public health or environment (IDAPA§ 58.01.02.350.02(a)).

The Idaho WQS specify if water quality monitoring indicates WQS are not being met, even with the use of BMPs or knowledgeable and reasonable practices, the state may request the designated agency evaluate and/or modify the BMPs to protect beneficial uses. If necessary, the state may seek injunctive or other judicial relief against the operator of a nonpoint source activity in accordance with the Idaho DEQ Director (Section 39-108, Idaho Code) and (IDAPA§ 58.01.02.350).

The WQS list designated agencies responsible for reviewing and revising nonpoint source BMPs. Designated agencies are Department of Lands for timber harvest activities, oil and gas exploration and development and mining activities; the Soil Conservation Commission (SCC) for grazing and agricultural activities; the Department of Transportation for public road construction; the Department of Agriculture (IDA) for aquaculture; and Idaho DEQ for all other activities (IDAPA§ 58.01.02.003). The Idaho WQS refer to existing authorities to control nonpoint source pollution sources in Idaho. Some of these authorities and responsible agencies are listed in Table 28.

Table 28. Regulatory Authority for Nonpoint Pollution Sources. Upper Owyhee Watershed.

Nonpoint Source BMPs	Primary Responsible Agency or Agencies	Code/Regulation or Authority Involved
Idaho Forest Practice Rules	Idaho Department of Lands, Board of Land Commissioners	Idaho Code §39-3602, IDAPA§ 58.01.02.003.62, IDAPA§ 58.01.02.350.03
Rules Governing Solid Waste Management	Idaho Department of Environmental Quality and the Health Districts	IDAPA§ 58.01.02.350.03(b)
Rules Governing Subsurface and Individual Sewage Disposal Systems	Idaho Department of Environmental Quality and the Health Districts	Idaho Code §39-3602, IDAPA§ 58.01.02.350.03(c), IDAPA§ 58.01.15
Rules and Standards for Stream-channel Alteration	Board of Water Resources	IDAPA§ 58.01.02.350.03(d)
Rules Governing Exploration and Surface Mining Operations in Idaho	Idaho Department of Lands, Board of Land Commissioners	Idaho Code §39-3602, IDAPA§ 58.01.02.350.03(e), IDAPA§ 58.01.02.003.62
Rules Governing Placer and Dredge Mining in Idaho	Idaho Department of Lands, Board of Land Commissioners	IDAPA§ 58.01.02.350.03(f)
Rules Governing Dairy Waste	Idaho Department of Agriculture	IDAPA§ 58.01.02.350.03.(g) or IDAPA§ 58.01.02.04.14

The BIA and the Shoshone-Paiute Tribes are responsible for administering, managing and protecting approximately 12.1% (122,375 acres) of all lands within the Upper Owyhee Watershed (Duck Valley Indian Reservation, Idaho). Tribal WQS and/or the EPA determine if any water quality limited segments are present within tribal boundaries. Any control actions will also be the responsibility of the BIA/ Shoshone-Paiute Tribes and/or the EPA.

The BLM is responsible for administering, managing and protecting approximately 73.8% (746,833 acres) of the land in the Upper Owyhee Watershed. The agency has authority to regulate, license and enforce land use activities that affect nonpoint source pollution control from the Taylor Grazing Act, the federal CWA, the Federal Land and Policy Management Act, the Public Rangelands Improvement Act, the National Environmental Policy Act, the Emergency Wetlands Resource Act, the Agricultural Credit Act, the Land and Water Conservation Act and the Executive Orders for Floodplain Management and Protection of Wetlands.

The BLM is active in several interagency efforts to integrate priorities and provide implementation opportunities and tools for nonpoint source activities, such as the State Technical Committee, State BMP Committee, Coordinated Resource Management Plan (CRMP) Committee, and Agricultural TMDL Action Committee. The BLM participates in several §319 grants statewide for prevention and control of nonpoint source pollution.

Past management activities by the BLM in this subbasin include some livestock exclusion from riparian areas, pasture management with planned grazing systems, reservoir development, spring or water development in uplands and streambank protection. The *Owyhee Resource Management Plan and Final Environmental Impact Statement* (ORMP) includes pollution control activities that will be implemented over the next several years (BLM 1999). This document only affects the portion of the watershed from Deep Creek west to the Oregon state line. The selected alternative includes grazing management, which is meant to attain proper functioning and satisfactory riparian conditions and meet or exceed Idaho WQS in streams within the described portions of the Upper Owyhee Watershed. Examples of potential management activities are proper timing of grazing to minimize soil erosion, grazing management that provides adequate residual stubble height and proposed funding for range development projects to support management adjustments over a 20- year period.

4.3 Implementation Strategies

Overview

The purpose of this implementation strategy is to outline the pathway by which a larger, more comprehensive, implementation plan will be developed 18 months after TMDL approval. The comprehensive implementation plan will provide details of the actions needed to achieve load reductions (set forth in a TMDL), a schedule of those actions, and specify monitoring needed to document actions and progress toward meeting state water quality standards. These details are typically set forth in the plan that follows approval of the TMDL. In the meantime, a cursory implementation strategy is developed to identify the general issues such as responsible parties, a time line, and a monitoring strategy for determining progress toward meeting the TMDL goals outlined in this document.

The geographic scope of this TMDL effort encompasses the entire Upper Owyhee Watershed 4th Field HUC, 17050104. The water bodies to be addressed include Castle Creek, Red Canyon Creek, Deep Creek, Nickel Creek, Pole Creek, Juniper Basin Reservoir, and Blue Creek Reservoir. These water bodies and the pollutants to be addressed in the Implementation Plan are located in Table 22. Section 1.1 describes the water bodies and the listed segments.

Responsible Parties

Development of the final implementation plan for the Upper Owyhee Watershed TMDL will proceed under the existing practice established for the state of Idaho. The plan will be cooperatively developed by Idaho DEQ, the Owyhee WAG, and other "designated agencies" with input from the established public process. Of the three entities, the WAG will act as the integral part of the implementation planning process to identify appropriate implementation measures. Other individuals may also be identified to assist in the development of the site-specific implementation plans as their areas of expertise are identified as beneficial to the process. Together, these entities will recommend specific control actions and will then, with the BAG, review the specific implementation plan before submitting it to Idaho DEQ. Idaho DEQ will act as a repository for approved implementation plans.

Designated state agencies are responsible for assisting with preparation of specific implementation plans, particularly for those sources for which they have regulatory authority or programmatic responsibilities. Idaho's designated state management agencies are located on Table 26.

To the maximum extent possible, the implementation plan will be developed with the participation of federal partners and land management agencies (i.e., NRCS, U.S. Forest Service, BLM, Bureau of Reclamation, etc.). In Idaho, these agencies, and their federal and state partners, are charged by the CWA to lend available technical assistance and other appropriate support to local efforts/projects for water quality improvements.

All stakeholders in the Upper Owyhee Watershed subbasin have a responsibility for implementing the TMDL. Idaho DEQ and the "designated agencies" in Idaho have primary responsibility for overseeing implementation in cooperation with landowners and managers. Their general responsibilities are outlined below.

- **Idaho DEQ** will oversee and track overall progress on the specific implementation plan and monitor the watershed response. Idaho DEQ will also work with local governments on urban/suburban issues.
- **IDL** will maintain and update approved BMPs for forest practices and mining. IDL is responsible for ensuring use of appropriate BMPs on state and private lands.
- **ISCC**, working in cooperation with local Soil and Water Conservation Districts and ISDA, the NRCS will provide technical assistance to agricultural landowners. These agencies will help landowners design BMP systems appropriate for their property, and identify and seek appropriate cost-share funds. They also will provide periodic project reviews to ensure BMPs are working effectively.

The designated agencies, WAG, and other appropriate public process participants are expected to:

- Develop BMPs to achieve LAs
- Give reasonable assurance that management measures will meet LAs through both quantitative and qualitative analysis of management measures
- Adhere to measurable milestones for progress
- Develop a timeline for implementation, with reference to costs and funding
- Develop a monitoring plan to determine if BMPs are being implemented, individual BMPs are effective, LA and WLA are being met, and water quality standards are being met

In addition to the designated agencies, the public, through the WAG and other equivalent processes, will be provided with opportunities to be involved in developing the implementation plan to the maximum extent practical. Public participation will significantly affect public acceptance of the document and the proposed control actions. Stakeholders (landowners, local governing authorities, taxpayers, industries, and land managers) are the most educated regarding the pollutant sources and will be responsible for implementing the control actions identified in the plan. Experience has shown that the best and most effective implementation plans are those that are developed with substantial public cooperation and involvement.

Adaptive Management Approach

The goal of the CWA and its associated administrative rules for Idaho is that water quality standards shall be met or that all feasible steps will be taken towards achieving the highest quality water attainable. This is a long-term goal in this watershed, particularly because nonpoint sources are the primary concern. To achieve this goal, implementation must commence as soon as possible.

The TMDL is a numerical loading that sets pollutant levels such that instream water quality standards are met and designated beneficial uses are supported. Idaho DEQ recognizes that the TMDL is calculated from mathematical models and other analytical techniques designed to simulate and/or predict very complex physical, chemical, and biological processes. Models and some other analytical techniques are simplifications of these complex processes and, while they are useful in interpreting data and in predicting trends in water quality, they are unlikely to produce an exact prediction of how streams and other waterbodies will respond to the application of various management measures. It is for this reason that the TMDL has been established with a MOS.

For the purposes of the Upper Owyhee Watershed TMDL, a general implementation strategy is being prepared for EPA as part of the TMDL document. Following this submission, in accordance with approved state schedules and protocols, a specific detailed implementation plan will be prepared for pollutant sources.

For nonpoint sources, Idaho DEQ also expects that implementation plans be implemented as soon as practicable. However, Idaho DEQ recognizes that it may take some period of time, from several years to several decades, to fully implement the appropriate management practices. Idaho DEQ also recognizes that it may take additional time after implementation has been accomplished before the management practices identified in the implementation plans become fully effective in reducing and controlling pollution. In addition, Idaho DEQ recognizes that technology for controlling nonpoint source pollution is, in many cases, in the development stages and will likely take one or more iterations to develop effective techniques. It is possible that after application of all reasonable best management practices, some TMDLs or their associated targets and surrogates cannot be achieved as originally established. Nevertheless, it is Idaho DEQ's expectation that nonpoint sources make a good faith effort to achieving their respective load allocations in the shortest practicable time.

Idaho DEQ recognizes that expedited implementation of TMDLs will be socially and economically challenging. Further, there is a desire to minimize economic impacts as much as possible when consistent with protecting water quality and beneficial uses. Idaho DEQ further recognizes that, despite the best and most sincere efforts, natural events beyond the control of humans may interfere with or delay attainment of the TMDL and/or its associated targets and surrogates. Such events could be, but are not limited to floods, fire, insect infestations, and drought.

For some pollutants, pollutant surrogates have been defined as targets for meeting the TMDLs. The purpose of the surrogates is not to bar or eliminate human access or activity in the basin or its riparian areas. It is the expectation, however, that the specific implementation plan will address how human activities will be managed to achieve the water quality targets and surrogates. It is also recognized that full attainment of pollutant surrogates (system potential vegetation, for example) at all locations may not be feasible due to physical, legal, or other regulatory constraints. To the extent possible, the implementation plan should identify potential constraints, but should also provide the ability to mitigate those constraints should the opportunity arise. If a nonpoint source that is covered by the TMDL complies with its finalized implementation plan, it will be considered in compliance with the TMDL.

Idaho DEQ intends to regularly review progress of the implementation plan. If Idaho DEQ determines the implementation plan has been fully implemented, that all feasible management practices have reached maximum expected effectiveness, but a TMDL or its interim targets have not been achieved, Idaho DEQ shall reopen the TMDL and adjust it or its interim targets and the associated water quality standard(s) as necessary.

The implementation of TMDLs and the associated plan is enforceable under the applicable provisions of the water quality standards for point and nonpoint sources by Idaho DEQ and other state agencies and local governments in Idaho. However, it is envisioned that sufficient initiative exists on the part of local stakeholders to achieve water quality goals with minimal enforcement. Should the need for additional effort emerge, it is expected that the responsible agency will work with land managers to overcome impediments to progress through education, technical support, or enforcement. Enforcement may be necessary in instances of insufficient action towards progress. This could occur first through direct intervention from state or local land management agencies, and secondarily through Idaho DEQ. The latter may be based on departmental orders to implement management goals leading to water quality standards.

In employing an adaptive management approach to the TMDL and the implementation plan, Idaho DEQ has the following expectations and intentions:

- Subject to available resources, Idaho DEQ intends to review the progress of the TMDLs and the implementation plans on a five-year basis.
- Idaho DEQ expects that designated agencies will also monitor and document their progress in implementing the provisions of the implementation plans for those pollutant sources for which they are responsible. This information will be provided to Idaho DEQ for use in reviewing the TMDL.
- Idaho DEQ expects that designated agencies will identify benchmarks for the attainment of TMDL targets and surrogates as part of the specific implementation plans being developed. These benchmarks will be used to measure progress toward the goals outlined in the TMDL.
- Idaho DEQ expects designated agencies to revise the components of their implementation plan to address deficiencies where implementation of the specific management techniques are found to be inadequate.
- If Idaho DEQ, in consultation with the designated agencies, concludes that all feasible steps have been taken to meet the TMDL and its associated targets and surrogates, and that the TMDL, or the associated targets and surrogates are not practicable, the TMDL may be reopened and revised as appropriate. Idaho DEQ would also consider reopening the TMDL should new information become available indicating that the TMDL or its associated targets and/or surrogates should be modified.

Monitoring and Evaluation

The objectives of a monitoring effort are to demonstrate long-term recovery, better understand natural variability, track implementation of projects and BMPs, and track effectiveness of TMDL implementation. This monitoring and feedback mechanism is a major component of the "reasonable assurance of implementation" for the TMDL implementation plan.

The implementation plan will be tracked by accounting for the numbers, types, and locations of projects, BMPs, educational activities, or other actions taken to improve or protect water quality. The mechanism for tracking specific implementation efforts will be annual reports to be submitted to Idaho DEQ.

The "monitoring and evaluation" component has two basic categories:
- Tracking the implementation progress of specific implementation plans; and
- Tracking the progress of improving water quality through monitoring physical, chemical, and biological parameters.

Monitoring plans will provide information on progress being made toward achieving TMDL allocations and achieving water quality standards, and will help in the interim evaluation of progress as described under the adaptive management approach.

Implementation plan monitoring has two major components:
- Watershed monitoring and

- BMP monitoring.

While Idaho DEQ has primary responsibility for watershed monitoring, other agencies and entities have shown an interest in such monitoring. In these instances, data sharing is encouraged. The designated agencies have primary responsibility for BMP monitoring.

Watershed Monitoring

Watershed monitoring measures the success of the implementation measures in accomplishing the overall TMDL goals and includes in-stream monitoring. Monitoring of BMPs measures the success of individual pollutant reduction projects. Implementation plan monitoring will also supplement the watershed information available during development of associated TMDLs and fill data gaps.

In the Upper Owyhee Watershed TMDL, watershed monitoring has the following objectives:

- Evaluate watershed pollutant sources,
- Refine baseline conditions and pollutant loading,
- Evaluate trends in water quality data,
- Evaluate the collective effectiveness of implementation actions in reducing pollutant loading to the mainstem streams and/or tributaries, and
- Gather information and fill data gaps to more accurately determine pollutant loading.

BMP/Project Effectiveness Monitoring

Site or BMP-specific monitoring may be included as part of specific treatment projects if determined appropriate and justified, and will be the responsibility of the designated project manager or grant recipient. The objective of an individual project monitoring plan is to verify that BMPs are properly installed, maintained, and working as designed. Monitoring for pollutant reductions at individual projects typically consists of spot checks, annual reviews, and evaluation of advancement toward reduction goals. The results of these reviews can be used to recommend or discourage similar projects in the future and to identify specific watersheds or reaches that are particularly ripe for improvement.

Evaluation of Efforts over Time

Annual reports on progress toward TMDL implementation will be prepared to provide the basis for assessment and evaluation of progress. Documentation of TMDL implementation activities, actual pollutant reduction effectiveness, and projected load reductions for planned actions will be included. If water quality goals are being met, or if trend analyses show that implementation activities are resulting in benefits that indicate that water quality objectives will be met in a reasonable period of time, then implementation of the plan will continue. If monitoring or analyses show that water quality goals are not being met, the TMDL implementation plan will be revised to include modified objectives and a new strategy for implementation activities.

Implementation Time Frame

The implementation plan must demonstrate a strategy for implementing and maintaining the plan and the resulting water quality improvements over the long term. The timeline should be as specific as possible and should include a schedule for BMP installation and/or evaluation, monitoring schedules, reporting dates, and milestones for evaluating progress. There may be disparity in timelines for different subwatersheds. This is acceptable as long as there is reasonable assurance that milestones will be achieved.

The implementation plan will be designed to reduce pollutant loads from sources to meet TMDLs, their associated loads, and water quality standards. Idaho DEQ recognizes that where implementation involves significant restoration, water quality standards may not be met for quite some time. In addition, Idaho DEQ recognizes that technology for controlling nonpoint source pollution is, in some cases, in the development stages and will likely take one or more iterations to develop effective techniques.

A definitive timeline for implementing the TMDL and the associated allocations will be developed as part of the implementation plan. This timeline will be developed in consultation with the WAG, the designated agencies, and other interested publics.

5. Total Maximum Daily Load

A TMDL prescribes an upper limit on discharge of a pollutant from all sources so as to assure water quality standards are met. It further allocates this load capacity (LC) among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation (WLA); and nonpoint sources, which receive a load allocation (LA). Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (40 CFR § 130) require a margin of safety (MOS) be a part of the TMDL.

Practically, the MOS is a reduction in the load capacity that is available for allocation to pollutant sources. The natural background load is also effectively a reduction in the load capacity available for allocation to human made pollutant sources. This can be summarized symbolically as the equation: LC = MOS + LA + WLA = TMDL. The equation is written in this order because it represents the logical order in which a loading analysis is conducted. First the load capacity is determined. Then the load capacity is broken down into its components: the necessary MOS is determined and subtracted and then the remainder is allocated among pollutant sources. When the breakdown and allocation is completed we have a TMDL, which must equal the load capacity.

Another step in a loading analysis is the quantification of current pollutant loads by source. This allows the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary in order for pollutant trading to occur. Also a required part of the loading analysis is that the load capacity be based on critical conditions – the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both load capacity and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

A load is fundamentally a quantity of a pollutant discharged over some period of time, and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for "other appropriate measures" to be used when necessary. These "other measures" must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads, and allow "gross allotment" as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

The Upper Owyhee Watershed has no point source discharges. All loads are associated with nonpoint sources and the TMDLs will be written for nonpoint sources only. No waste load allocations will be developed.

5.1 Instream Water Quality Targets

The in-stream water quality targets for the water quality limited segments within the Upper Owyhee Watershed TMDL are to provide full support for the designated and existing uses (IDAPA§ 58.01.02.054.02).

Through the Upper Owyhee Watershed SBA it has been determined temperatures are exceeding state of Idaho WQS. Water temperature data showed the criteria for the protection of CWAL and salmonid spawning were exceeded during critical periods. Analysis of biological communities showed sediment was impairing the biota of the stream substrate in Castle Creek, Deep Creek, and Nickel Creek. Turbidity levels in Juniper Basin and Blue Creek Reservoirs exceeded literature values, which the state of Idaho WQS are based on for the protection of CWAL. Both the temperature criteria and the turbidity criteria are set at levels to establish a threshold to maintain or restore existing or designated uses. Table 29 shows the targets to achieve WQS.

Table 29. Water Quality Targets for the Water Quality Limited Segments. Upper Owyhee Watershed.

Pollutants	Water Bodies	Selected Targets
Sediment	Juniper Basin Reservoir Blue Creek Reservoir Deep Creek Castle Creek Nickel Creek	**For Reservoirs:** Turbidity no greater than 25 NTU **For Streams:** TSS no greater than 50 mg/l as a monthly average and no greater than 80 mg/l lasting more than 14 days **Stream Substrate:** Substrate composed of fine sediment of less than 6 mm for no greater than 30% of given area of stream substrate, confined to riffle areas **Stream Bank Erosion Rates:** As defined by load capacity
Temperature	Deep Creek Pole Creek Castle Creek Red Canyon Creek	**Salmonid Spawning:** Water temperatures of 13° C or less with a maximum daily average no greater than 9° C **Cold Water Aquatic Life:** Water temperatures 22° C degrees C or less with a maximum daily average of no greater than 19°C. **Shade Component:** Shade required to meet targets as determined through the use of the SSTEMP[a] model

a Stream Segment Temperature Model (Bartholow 1999)

Design Conditions

The critical time periods for maintaining cool waters is during the summer months, mainly June through August when warm ambient air temperatures and solar radiation have the greatest impact on water temperature. The general salmonid spawning period is from March 15, through July 15 (Idaho DEQ 2001). Most water temperature data indicate the period from June 1 through July 1 is the critical period for salmonid egg development and fry emergence in the streams in the Upper Owyhee Watershed. Water temperature was predicted through the Stream Segment Temperature Model (SSTEMP) (Bartholow 1999) and the hydrology, or predicted discharge was, determined through the U.S. Geological Survey (USGS) model developed by Hortness and Berenbrock (2001). Through the discharge model, low flows at “Q.80” were determined. This flow of Q.80 represents the predicted flow at 80% of the exceedance of the monthly baseflow. Once the Q.80 was determined, the standard error of estimate was used to determine the lowest possible flow calculated by the model. This low flow was then applied to the SSTEMP model as a means of determining the most critical period for water temperature. Explanation of the models used and validations are located in Appendix D.

Sediment, both suspended and bedload, appears to be critical in a year-round loading analysis. Suspended sediment has impaired CWAL by interfering with the filter feeding capability of macroinvertebrates, while bedload sediment has reduced the amount of available interstitial space of the substrate. This space is required for salmonid spawning (redd construction), fry development, and habitat for macroinvertebrates.

To determine sediment loading, the discharge model developed by Hortness and Berenbrock (2001) was used. Each month's mean discharge was calculated and used for the load analysis.

The major components of nonpoint source management are implementing remedial activity and maintaining that activity. Although the critical periods may be during the summer months, year round management is key to achieve the goals and targets. The response time to changes in management practice will take 20-100 years in some places. The presence and maintenance of good plant vigor, stable streambanks, and stream morphology are important components of the temperature and sediment TMDLs and are required to be maintained during non-critical periods.

Monitoring Points

Monitoring points should follow stations established in the Upper Owyhee Watershed Monitoring Plan (Ingham 2000). However, as land management agencies develop land use plans for each particular land use, monitoring should be conducted to determine BMP effectiveness and compliance with TMDL goals and targets. Since some of the established monitoring points are located on private holdings, permission to enter these sites should be established. Monitoring sites on public lands will be the responsibility of the appropriate land management agency.

Monitoring parameters should include: instream water column TSS (Ralston 1978), stream substrate fine sediment (Burton 1991), flow (Ralston 1978), canopy density (Burton 1991), topographic shading (Burton 1991), stream bank erosion rates (NRCS 1983) and temperature logger placement (Zaroban 2000).

For the two reservoirs, Blue Creek and Juniper Basin, a literature value protecting CWAL of 25 NTUs was chosen as the target. Turbidity monitoring on Mountain View Reservoir on the Shoshone-Paiute Duck Valley Indian Reservation may provide a reference level that could be incorporated into a modification of the TMDL. However, the allocation for turbidity and a MOS will be set. Changes to the TMDL may be made as more information is collected.

Seasonal Variation

The TMDL must account for critical conditions and seasonal variations. In this case, the analysis is based on both critical conditions and seasonal variability, the periods when water temperatures are exceeding state WQS. The two periods include salmonid spawning (spawning and incubation) and CWAL. The temperature analysis was also based on the lowest flow determined by the use of the discharge model (Hortness and Berenbrock 2001), which accounts for the most critical condition. Seasonal variations were also accounted for by analyzing the monitoring data and then focusing on the period of highest temperatures during late spring and early to mid summer.

The TMDL must also account for critical conditions and seasonal variation for sediment delivery. For streams and reservoirs, it is inherently a non-seasonal phenomenon with a disproportionate amount of erosion associated with snowmelt (December through May) and heavy precipitation events, which can occur throughout the year. Sediment delivery is also variable on an annual basis, with erosion rates dependent from year to year on storm events, snow melt duration and winter snowpack. To account for this annual variability, the TMDL and load allocations are expressed as a yearly average. Similarly, the approach used in this TMDL is to identify indicators that are reflective of the net effects from year to year.

5.2 Load Capacity

Capacity, or load capacity is defined as the greatest amount of loading that a water can receive without violating water quality standards (40 CFR §130.2(f)).

Temperature (Heat) Load Capacity

The temperature TMDL will establish a water temperature capacity and reduction requirements based on the numeric criteria in the state Idaho WQS. Target selection is based on a mass/unit/time measurement of joules/meter^2/second (joules/m^2/sec). The SSTEMP model (Bartholow 1999) was utilized to determine the reduction of joules/m^2/sec required to achieve state of Idaho WQS. The SSTEMP model also indicates the amount of shade required to obtain the desired joules/m^2/sec. Thus, the load capacity will use the mass/unit/time measurement and the surrogate measure of percent shading. Appendix D describes the SSTEMP results plus the validation methods used. Table 30 shows the temperature load capacity for the water quality limited segments. Not all segments listed are §303(d) listed segments. However, for the month of June, the SSTEMP model indicated upstream water temperature reductions needs to occur if temperature load capacities are to be met in listed segments.

To address the heat loading capacity, a surrogate measurement of percent shade is utilized. The shading capacity is determined by the amount of joules/meter^2/sec capacity. As the amount of shade increases, the amount of heat exchange to the water body decreases. Table 31 shows predicted percent shade required to achieve WQS on §303(d) listed segments and on those segments not on the §303(d) list.

A simple definition of temperature exchange from hot to cold material is the form of heat. Heat is not defined as the energy itself, but the capability to transfer energy from one source to another based on temperature, hot to cold. The “Le Systeme International d’ Unites” or “SI” for energy is the joule. The joule is the measurement of “work,” “kinetic energy” or “potential energy.” Thus, the use of the term joule(s) within this document is in reference to the exchange of energy from one source to another (Cutnell and Johnson 1989).

A simple relation between heat (energy) and temperature can be seen in the following formula (Cutnell and Johnson 1989):

$$Q = cm\Delta T$$

where Q = Heat (energy)
c = specific heat capacity
m = mass
ΔT = delta temperature (Δ = an increment of a variable)

As temperature changes, the amount of energy or heat, flows from the hotter mass to the colder mass. As an example, a glass of water at room temperature is placed in a refrigerator. Since energy "flows" from hotter to colder, energy from the warmer water flows to the colder air within the refrigerator causing the a loss of energy within the water resulting in colder water. Thus, an overall loss of energy from the water.

Heat exchange between water and the environment can be affected by a variety of factors, including physical and atmospheric attributes. These factors influence the overall heat fluxes (gain or loss) in the water. Figure 16 shows a schematic of how heat fluxes that may affect the transfer of heat in a water body.

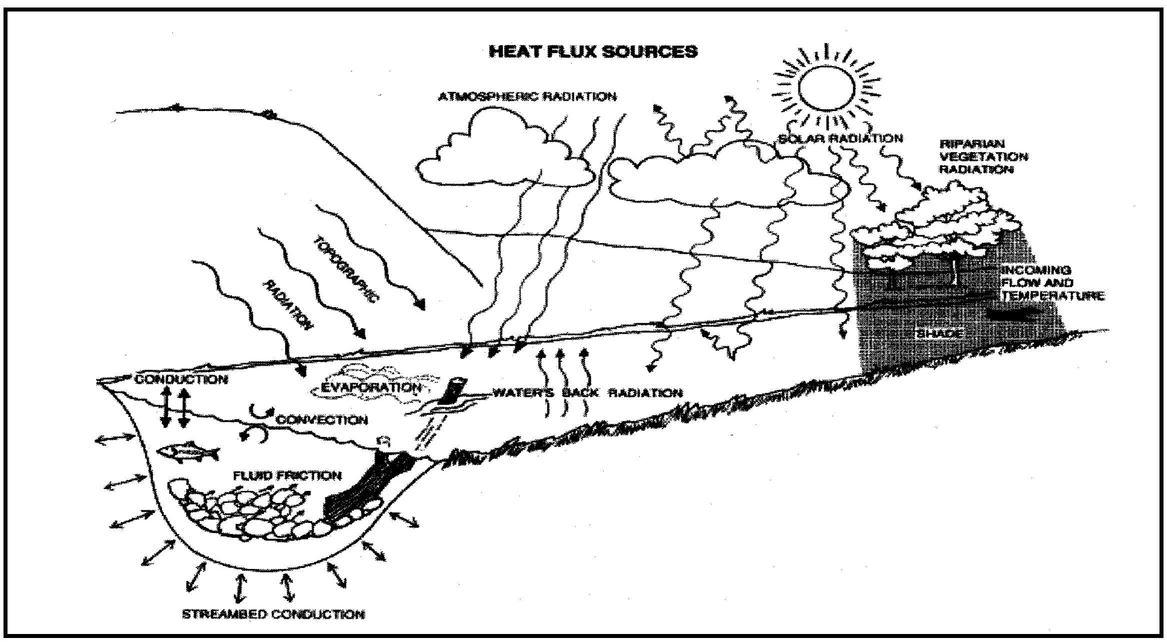


Figure 16. Possible Heat Flux Sources (Re-Printed from Bartholow 1999). Upper Owyhee Watershed.

Table 30 indicates that some load capacity a negative value for joules/m^2/sec. This negative value is an overall sum of the different <u>net</u> mean heat fluxes losses or gains. The mean heat fluxes are governed by a variety of factors including convection, conduction, evaporation, backwater radiation, atmosphere, friction, solar radiation and vegetation component. The SSTEMP model (Bartholow 1999) generates these values based on input from other parameters. A negative value produced by the model indicates that there is a negative heat flux based on the input values entered. In other words, the negative value would indicate there is a greater loss of heat than heat gain (a loss of energy). Thus, temperature would decrease based on the values entered. This provides the required link between heat source and shade.

It should be remembered that the SSTEMP model provides for a gross estimate of heat loss or gains brought on by changing vegetation shade. There are many unknowns to determine what increase vegetation may have on channel width, channel length, air temperature, relative humidity, wind speed or other physical/climatic attributes that will affect water temperature. SSTEMP is only as reliable as the data entered. Thus, as more information is collected, the model can be re-calibrated to reflect certain segment actual conditions.

On Table 31 shading requirements (load capacity) vary from month to month, with the highest percent shade required in June. This higher shade requirement for June is a result of a much lower temperature criteria (9^oC) that must be met. Thus, a greater amount of solar radiation reduction is required. For July and August the criteria to be met is 22^oC or less (maximum daily temperature). The SSTEMP model does have limitations for estimating maximum daily temperatures. However, the model does provide a starting point for further evaluations. The model predicted the shade component is not as great as required in June. Both July and August are shown as a comparison. The month of July shows the most stringent level of heat reduction required to achieve criteria of 22^oC and the support of CWAL.

Table 30. Heat Load Capacity for Cold Water Aquatic Life, Salmonid Spawning and Incubation Periods. Load Capacity Support for Stream Segments. Upper Owyhee Watershed.

Stream[a]	June Load Capacity SS[b] Criteria of 9°C MDAT[c] joules/m²/sec	July Load Capacity CWAL[d] Criteria of 22°C MDT[e] joules/m²/sec	August Load Capacity CWAL Criteria of 22°C MDT joules/m²/sec	Method of Estimated[f]
Upper Deep Creek	5.34	68.46	85.49	SSTEMP
Middle Deep Creek	4.87	55.06	24.16	SSTEMP
Deep Creek below Nickel Creek to Pole Creek	6.47	16.25	148.16	SSTEMP
Lower Deep Creek	0.87	15.88	-52.25	SSTEMP
Upper Pole Creek	37.67	457.31	432.10	SSTEMP
Lower Pole Creek	3.52	46.26	47.76	SSTEMP
Castle Creek	44.06	470.49	468.64	SSTEMP
Red Canyon	40.73	473.40	391.34	SSTEMP
Nickel Creek	58.31	475.02	349.33	SSTEMP
Hurry Back Creek	52.49	481.22	352.87	SSTEMP
Nip and Tuck Creek	75.00	486.22	352.87	SSTEMP
Current Creek	53.18	438.08	356.41	SSTEMP
Camas Creek	32.64	444.84	336.76	SSTEMP
Camel Creek	35.69	448.66	377.48	SSTEMP
Bull Gulch	33.64	450.10	338.86	SSTEMP
Beaver Creek	43.87	467.67	345.16	SSTEMP
Upper Dickshooter Creek	28.39	448.37	339.21	SSTEMP
Lower Dickshooter Creek	82.81	93.40	46.57	SSTEMP

Bold = 1998 ä303(d) Listed Segments,b. salmonid spawning, c. maximum daily avergae temperature, d. cold water aquatic life,e.maximum daily Temperature, f. .Stream Segment Temperature Model (Bartholow 1999)

Table 31. Shade Requirements to Achieve Load Capacity for Stream Segments. Upper Owyhee Watershed.

Stream[a]	June Load Capacity SS[b] Criteria of 9^{o}C MDAT[c] Percent Shade	July Load Capacity CWAL[d] Criteria of 22^{o}C MDT[e] Percent Shade	August Load Capacity CWAL Criteria of 22^{o}C MDT Percent Shade	Method of Estimate[f]
Upper Deep Creek	100	52	59	SSTEMP
Middle Deep Creek	100	57	57	SSTEMP
Lower Deep Creek	100	66	67	SSTEMP
Deep Creek below Nickel Creek to Pole Creek	100	58	57	SSTEMP
Upper Pole Creek	96	96	58	SSTEMP
Lower Pole Creek	100	65	60	SSTEMP
Castle Creek	95	95	58	SSTEMP
Red Canyon Creek	94	94	57	SSTEMP
Nickel Creek	88	88	56	SSTEMP
Hurry Back Creek	92	95	54	SSTEMP
Nip & Tuck Creek	87	87	54	SSTEMP
Current Creek	91	91	53	SSTEMP
Camas Creek	98	98	61	SSTEMP
Camel Creek	97	97	62	SSTEMP
Bull Gulch	98	98	62	SSTEMP
Beaver Creek	97	97	59	SSTEMP
Upper Dickshooter Creek	100	100	62	SSTEMP
Lower Dickshooter Creek	94	65	67	SSTEMP

Bold = 1998 ä303(d) Listed Segments, b. salmonid spawning, c. maximum daily average temperature, d. cold water aquatic life, e.maximum daily temperature, f. .Stream Segment Temperature Model (Bartholow 1999)

Sediment Load Capacity

Idaho utilizes a narrative standard for sediment. The standard states, "Sediment shall not exceed quantities specified in Sections 250 and 252, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in

Section 350" (IDAPA §58.01.02.200.08). The water bodies that have been determined to be impaired by sediment are required to be addressed through the TMDL process, IDAPA §58.01.02.054.02 (Section 2.3 and 2.4). The TMDL process will establish a sediment TMDL based on three criteria; percent fines as related to substrate, water column sediment load and turbidity. The numeric load capacity for these three parameters have been established based on literature review and/or sediment load capacities established in other TMDL developed by the state of Idaho. The load capacity as defined earlier describes the greatest amount of loading that a water can receive without violating water quality standards (40 CFR §130.2(f)).

Water Column Load

The targets set for water column load is based on values obtained from TMDLs developed in watersheds with similar characteristics (e.g. Bruneau River, Idaho DEQ 2000*d*). For the streams that enter into reservoirs, stream sediment load capacity will be based on water column loading at 50 mg/l for a monthly average and/or 80 mg/l not to exceed fourteen days. Table 32 provides load capacity for water bodies that flow into the reservoirs, along with the other water bodies with a TMDL required to address sediment. It should be noted that the water bodies upstream of the reservoirs are not impaired by sediment, but are sources of sediment to the reservoirs.

Table 32. Sediment Load Capacity for Stream Segments. Upper Owyhee Watershed.

Stream	Flows[a] (cfs)	Load Capacity at 50 TSS[b] mg/l (tons/year)	Load Capacity at 80 TSS mg/l (tons/year)	Method of Estimation[c]
Deep Creek	52.0	2555	4088	Flow Concentration
Castle Creek	11.8	579	927	Flow Concentration
Nickel Creek	0.39	19	31	Flow Concentration
Blue Creek above Blue Creek Reservoir	6.74	331	530	Flow Concentration
Juniper Creek above Juniper Basin Reservoir	1.96	96	154	Flow Concentration

Discharge Determined by Hortness and Borenbrook 2001, annual discharge rate, b. Total Suspended Solids, c. Standards Methods 18th Edition

Surrogate Targets

The surrogate targets do not easily fit the mass/unit/time definition as described in 40 CFR 130.2(i). However, description of the current condition of the targets may be appropriate.

Substrate Targets

For sediment, the primary determination a beneficial use is impaired was through the use of biological indicator species, periphyton and macroinvertebrates (Clark 2001 and Bahls 2000 and 2001). A study conducted by Idaho State University (Relyea, Minshall and Danehy 2000) has provided a link between a biological indicator and a physical attribute of stream morphology, stream substrate and percent fines. The Relyea, Minshall and Danehy (2000) study indicated that a threshold of greater than 30% of the substrate of less than 6mm would produce Plecoptera (stoneflys) that are tolerant of sediments. Substrate less than 30% produced species that are more intolerant of sediment. With these biological indicators in mind, and a sediment link that has been developed for the state of Idaho, the targets recommended by Relyea, Minshall and Danehy (2000) is an appropriate surrogate to determine the loading capacity as related to sediment loading. Percent fines substrate targets are presented in Table 33.

Table 33. Percent Fine Load Capacity. Upper Owyhee Watershed.

Stream	Load Capacity 30%[a]
Deep Creek	30%
Nickel Creek	30%
Castle Creek	30%

<6 mm

Turbidity Targets

With the determination CWAL is impaired in both water bodies, a load capacity is required to be established (IDAPA §58.01.02.054.02) (Bahls 2000 and 2001). Most literature values indicate turbidity levels above 25 NTUs impair beneficial uses (Lloyd 1987, Sigler et al. 1984 and Bash, Berman and Bolton 2001). Table 34 shows the load capacity for turbidity.

Table 34. Turbidity Load Capacity for Reservoirs. Upper Owyhee Watershed.

Stream	Load Capacity (NTUs)[a]
Blue Creek Reservoir	25
Juniper Basin Reservoir	25

a. Nephelometric Turbidity Unit

Streambank Targets

The water column targets set for water bodies, either the streams that flow into the reservoirs or the other impaired streams, provide for a link to the pollutant source, streambanks. As demonstrated in Table 32, a mass/unit/time capacity is formulated. With a set annual load capacity in tons/year a surrogate target can be established for streambank erosion, tons/mile/year. This is a linear measurement of streambank stability and a quantity target for streambank erosion rates. The surrogate measurement for streambank load capacity is located in Table 35.
The water column targets set for water bodies, either the streams that flow into the reservoirs or the other impaired streams, provide for a link to the pollutant source, streambanks.

Table 35. Target Stream Bank Load Capacity for Stream Segments. Upper Owyhee Watershed.

Stream	Stream Bank Erosion Rate Load Capacity at 50 mg/l (tons/mile/year)	Method of Estimation[a&b]
Deep Creek	9.7	Flow Concentration, NRCS 1983
Castle Creek	48.3	Flow Concentration, NRCS 1983
Nickel Creek	10.6	Flow Concentration, NRCS 1983
Blue Creek above Blue Creek Reservoir	8.8	Flow Concentration, NRCS 1983
Juniper Creek above Juniper Basin Reservoir	3.8	Flow Concentration, NRCS 1983

a. Standards Methods 18th Edition, b.Natural Resource Conservation Sevice

5.3 Estimates of Existing Pollutant Load

Estimate of Existing Temperature (Heat) Loading

Current loads for temperature are estimated with the use of Hortness and Berenbrock (2001) discharge model and the SSTEMP (Bartholow 1999) temperature model. Regulations allow that loading "…may range from reasonably accurate estimates to gross allotments, depending on the available of data and appropriate techniques for predicting the loading (40 CFR §130.2(I)). The SSTEMP model has been incorporated into previous temperature TMDLs (Washington Department of Ecology 2001). The SSTEMP model has proven to provide adequate gross allotments.

Existing solar radiation and heat transfer are represented in the current load in joules/m^2/second. However, the current load of joules/m^2/second is not totally representative of all reaches where temperature analyses were preformed. Topographic shading estimates were taken from 7.5-minute topographic maps for different segments. In some situations the topographic shade made up 35% of the total shade component. Current vegetation shade was usually placed at zero with the idea that once more information is gathered the implementation of BMPs for that segment can be adjusted. However, even without this high amount of uncertainty, the load capacity will not change.

Azimuth siting is based on the general higher elevation to lower elevation aspect. Most segments have meanders that will change the aspect, but generally these changes in aspect are minor and the overall aspect (usually north to south) was a steady state input for the entire reach. Stream width and depth parameters were set near conditions found throughout the Upper Owyhee Watershed by BURP evaluations. This setting was near a ratio of 25:1. Width-depth ratios were then adjusted to near 12:1 for the final analysis to compensate for future changes in stream morphology caused by increased vegetation and bank stability. It should be pointed out the changes in width-depth ratio without changes to vegetation cover produced some change in the amount of heat transfer and some change in water temperature. An average reduction of less than 0.7 ^{o}C in daily average maximum and minimum temperatures was noted.

Overall the use of the SSTEMP model provided an adequate estimate of the current heat load to segments impaired by temperature. Table 36 shows the estimated existing load.

Table 36. Estimated Existing Heat Load in Stream Segments. Upper Owyhee Watershed.

Stream[a]	Existing Load June joules/m^2/sec	Existing Load July joules/m^2/sec	Existing Load August joules/m^2/sec	Method of Estimation[b]
Upper Deep Creek	20.81	11.36	32.68	SSTEMP
Middle Deep Creek	27.52	51.60	35.21	SSTEMP
Lower Deep Creek	8.37	15.54	-41.42	SSTEMP
Deep Creek below Nickel Creek to Pole Creek	25.56	27.54	35.21	SSTEMP
Upper Pole Creek	241.66	566.77	432.10	SSTEMP
Lower Pole Creek	5.62	52.46	-0.83	SSTEMP
Castle Creek	274.04	607.76	468.64	SSTEMP
Red Canyon	191.21	523.71	391.34	SSTEMP
Nickel Creek	190.91	520.37	390.37	SSTEMP
Hurry Back Creek	246.21	571.11	446.76	SSTEMP
Nip & Tuck Creek	242.46	568.79	429.09	SSTEMP
Current Creek	191.91	523.40	391.09	SSTEMP
Camas Creek	260.69	588.57	442.25	SSTEMP
Camel Creek	235.30	567.07	428.34	SSTEMP
Bull Gulch	191.66	569.56	448.17	SSTEMP
Beaver Creek	273.29	607.14	468.07	SSTEMP
Upper Dickshooter Creek	274.12	591.40	468.46	SSTEMP
Lower Dickshooter Creek	83.39	112.68	28.26	SSTEMP

a. 1998 ä303(d) Listed Segments, b. Stream Segment Temperature Model (Bartholow, 1999)

Estimate of Existing Sediment Loading

Water Column Loading

Estimating sediment loads in the Upper Owyhee has proven more difficult. Little to no data and with limited access too many segments have compounded the difficulties in estimating existing loading. The use of the USGS annual streamflow model (Hortness and Berenbrock 2001) does provide a gross estimate of flows that may be found in streams and rivers in the Upper Owyhee Watershed. With available flow estimates, load capacity targets can be made based on expected sediment concentration recommendations. The values of 80 mg/l and 50 mg/l represent in-stream water quality targets that have been incorporated into other sediment TMDLs in the state of Idaho (e.g., Lower Boise River TMDL and Bruneau River TMDL). It is believed the use of these concentration levels provides an adequate estimate to protect existing uses in the Upper Owyhee Watershed.

However, to establish a current sediment load based on in-stream water column loads is impossible. Data is available to provide a gross estimate based on streambank erosion found in the Succor Creek watershed and provided by a study completed for a TMDL for that watershed (HUC 17050103). Horsburgh (2002) found current streambank erosion rates in the watershed were between 13 to 215 tons/mile/year. Table 37 shows the gross estimates of possible in-water column sediment concentrations for those streams required to have a sediment load allocation. These concentrations are based on low and high yield estimates from stream bank erosion rates of 13 to 214 tons/mile/year.

Table 37. Estimated In-Stream Concentrations based on Streambank Erosion. Upper Owyhee Watershed.

Stream	Miles of 2nd and Larger Order Streams	Estimated Flow[a] cfs	Estimated Concentration Low Yield at 13 tons/mile/year (mg/l)	Estimated Concentration High Yield at 214 tons/mile/year (mg/l)	Method of Estimation
Deep Creek	262.6	52.0	67	1098	Based on probable bank erosion yields of 13-214 tons/mile/year
Castle Creek	12.0	11.8	13	218	Based on probable bank erosion yields of 13-214 tons/mile/year
Nickel Creek	1.8	0.4	59.7	983	Based on probable bank erosion yields of 13-214 tons/mile/year
Blue Creek above Blue Creek Reservoir	37.7	6.7	49.4	814	Based on probable bank erosion yields of 13-214 tons/mile/year
Juniper Creek above Juniper Basin Reservoir	25.0	2.0	250	4114	Based on probable bank erosion yields of 13-214 tons/mile/year

a Flow from Hortness and Borenbrook (2001)

The data presented in Table 37 does not accurately show the actual loading and many assumptions would have to occur. Mainly, erosion rates would be equal throughout the 2nd order water bodies for any given stream. Secondly, the flow rates used to calculate the estimated sediment concentrations are an annual discharge rate. Discharge rates can vary greatly depending on a variety of factors such as storm events, snow melt, drought conditions and other meteorological and physical conditions. However, the data presented does show the wide variability of sediment load that could be encountered through streambank erosion.

The data in Table 37 does not represent possible sediment load from overland sources and would only represent streambank sources. Overland soil erosion rates have been determined using the modified universal soil loss equation as prepared by the BLM during the development of the RMP (Seronko 2002). This study provided some computed values for expected soil erosion rates in the Upper Owyhee Watershed. However, the general overall soil loss is broken down for an entire watershed and does not take into account different landforms such as stream channels. Also, the erosion rate determined by the ORMP only indicates soil movement and not delivery rates to surface waters. As noted in Table 38, overland soil erosion in the Upper Owyhee Watershed could exceed the load capacity by 30 to 790 times for both the 50 mg/l and 80 mg/l targets.

In the Upper Owyhee Watershed it is expected that streambank erosion is the largest contributor to surface water sediment loads. As more stream bank information and more accurate overland erosion delivery rates are collected by land management agencies, the value presented in Tables 37 and 38 will be adjusted.

Table 38. Estimated Overland Erosion. Upper Owyhee Watershed.

Stream	Watershed Total Size (acres)	Estimated High Yield at 2.4 tons/year (tons/year)	Estimated Low Yield at 1.1 tons/year (tons/year)	Method of Estimation
Deep Creek	275,563	661,351	303,119	MUSLE, Seronko, 2002
Castle Creek	15,372	36,893	16,909	MUSLE, Seronko, 2002
Nickel Creek	2,070	4,968	2,277	MUSLE, Seronko, 2002
Blue Creek above Blue Creek Reservoir	39,224	94,138	58,356	MUSLE, Seronko, 2002
Juniper Creek above Juniper Basin Reservoir	53,051	127,322	43,146	MUSLE, Seronko, 2002

a Modified Universal Soil Loss Equation

Surrogate Targets

The surrogate targets do not easily fit the mass/unit/time definition as described in 40 CFR 130.2(i). However, description of the current condition of the targets may be appropriate.

Substrate

Data collected from the various BURP monitoring sites along with the various monitoring dates indicated that stream substrate percent fines (<6mm) varied from 15% to 55%. Most of the sites that had SMI scores that indicated the streams were not fully supporting CWAL had percent fines (<6mm) greater than 30%. More information will be required to determine the site potential for different segments that will have a stream substrate target established.

Turbidity

Turbidity levels collected in 2001 showed a level of 65 NTUs for Blue Creek Reservoir and 70 NTUs for Juniper Basin Reservoir. The estimate for the possible existing loading from upstream sources is described in Tables 37 and 38.

5.4 Allocation

All pollution sources are from nonpoint or natural sources. Allocations will be based on land use, which in the majority of the Upper Owyhee Watershed consists of rangeland. For sediment allocations riparian areas have been calculated, but represent a small portion of the land use in the sub-watersheds. Forested areas within the watershed do not contain harvestable types of timber. Thus, forest practices are not an issue and those areas identified as forested are incorporated into the primary land use of rangeland. This designation would only effect the sediment allocation in the Deep Creek and Castle Creek subbasins where forested land use makes up approximately 28% and 32% respectively. Juniper Basin and Blue Creek do not contain any forested areas. As with sediment, allocations for temperature reductions will be based on the single land use of rangeland.

Margin of Safety

The Clean Water Act and its regulations require a MOS to address uncertainty in the TMDL. For temperature, certain amounts of conservative assumption are built into the TMDL to apply an implicit MOS. For the temperature TMDL, conservative assumptions concerning physical attributes other than increased shade were made that may account for uncertainties in the model analysis that provide for a MOS:

Temperature

> Enhancement of streambank vegetation will promote bank stability creating better properly functioning stream morphology. This will increase ground water supply and the hyporheic flow conditions with a reduction in water temperature. These effects were not accounted for in the temperature analysis.
>
> The SSTEMP model has limitations for streams that may be gaining or losing reaches. Reaches that gain through groundwater recharge offer cold water refugia for CWAL. These effects were not accounted in the temperature analysis.
>
> The reestablishment of access to a floodplain will enhance stream morphology. With the potential to develop a flood plain, stream conditions will allow for more sinuosity, decreased width-depth ratio and higher frequency of pools, which offer cooler refuge areas for CWAL. These effects were not accounted in the temperature analysis.
>
> Reduced sediments can be expected to increase pool depth and pool frequency. This increase will also provide offer cooler refuge areas for CWAL. These effects were not accounted in the temperature analysis.
>
> The flow model utilized determines flows at the most critical low flow periods. Along with the critical flow conditions that may be encountered, the critical condition analysis

and model validation followed data collected during two years of drought conditions.. With increased available water in “normal” water years increased flows and lower water temperature can be expected than those observed in 2000 and 2001. These effects were not accounted in the temperature analysis.

Sediment

For sediment, some uncertainty and unknowns are present that would demonstrate a MOS is required. Some of these uncertainties include the lack of knowledge on the amount of sediment that is delivered to water bodies from upland sources, lack of data to demonstrate the existing load and what would constitute a natural loading. Another major unknown is the particular reach’s streambank erosion rates, both induced and natural. Some reaches, especially in Deep Creek, may have erosion rates well below the target due to geology and stream morphology.

With these uncertainties, it is proposed that an explicit MOS of (10%) of the load capacity be applied to the sediment load allocation. The Bruneau River TMDL (Idaho DEQ 2000) established a similar MOS allocation. The MOS will be an allocation that can not be expected to be reduced, but as an allocation to the uncertainty of the total allocation to meet the load capacity. As more information is collected by land management agencies, the MOS may be adjusted to reflect the natural condition.

Remaining Available Load

The remaining load is the load allocation (LA). This load is to be allocated to the human induced nonpoint source pollutants. This component of the load capacity for the load allocation can be calculated by the following formula:

$$LC = MOS + WLA + LA + WLA = TMDL$$

Since there is no point source for the waste load allocation, the following formula is used to calculate the load allocation:

$$LC = LA + MOS = TMDL$$

For temperature there is an implicit MOS, therefore the MOS for temperature is zero. For sediment the MOS will be applied at 10% of the load capacity. Therefore the following formulas will be applied for temperature and sediment;

For temperature:

$$LA = LC = TMDL$$

For Sediment:

$$LA = LC - 10\% \text{ of } LC = TMDL$$

Temperature Load Allocations and Targets

For temperature, the entire load allocation is assigned to the current primary land use, rangeland. As defined in 40 CFR 130.2(i), the load allocation will be based in mass/per/unit/time. Table 39 shows the LA calculations in joules/m^2/sec for the temperature portion of the TMDL. However, the SSTEMP model provided surrogate targets that may be more useful for land management agencies and a more appropriate for site potential application. These targets are located in Table 40. Since the targets for water body shading are more stringent for June, this will be the target that will have to be met.

Table 39. June, July and August Load Allocation for Temperature. Upper Owyhee Watershed.

Stream[a]	Land Use	June Load Allocation SS[b] Criteria of 9°C MDAT[c] joules/m²/sec	July Load Allocation CWAL[d] Criteria of 22°C MDT[e] joules/m²/sec	August Load Allocation CWAL Criteria of 22°C MDT joules/m²/sec	Method of Estimate[f]
Upper Deep Creek	Rangeland	5.34	68.46	85.49	SSTEMP
Middle Deep Creek	Rangeland	4.87	55.06	24.16	SSTEMP
Deep Creek below Nickel Creek to Pole Creek	Rangeland	6.47	16.25	148.16	SSTEMP
Lower Deep Creek	Rangeland	0.87	15.88	-52.25	SSTEMP
Upper Pole Creek	Rangeland	37.67	457.31	432.10	SSTEMP
Lower Pole Creek	Rangeland	3.52	46.26	47.76	SSTEMP
Castle Creek	Rangeland	44.06	470.49	468.64	SSTEMP
Red Canyon	Rangeland	40.73	473.40	391.34	SSTEMP
Nickel Creek	Rangeland	58.31	475.02	349.33	SSTEMP
Hurry Back Creek	Rangeland	52.49	481.22	352.87	SSTEMP
Nip and Tuck Creek	Rangeland	75.00	486.22	352.87	SSTEMP
Current Creek	Rangeland	53.18	438.08	356.41	SSTEMP
Camas Creek	Rangeland	32.64	444.84	336.76	SSTEMP
Camel Creek	Rangeland	35.69	448.66	377.48	SSTEMP
Bull Gulch	Rangeland	33.64	450.10	338.86	SSTEMP
Beaver Creek	Rangeland	43.87	467.67	345.16	SSTEMP
Upper Dickshooter Creek	Rangeland	28.39	448.37	339.21	SSTEMP
Lower Dickshooter Creek	Rangeland	82.81	93.40	46.57	SSTEMP

Bold = 1998 ä303(d) Listed Segments, b. salmonid spawning, c. Maximum Dauly Average Temperature, d.cold water aquatic life, e.Maximum Daily Temperature

Steam Segment Temperature Model (Bartholow 1999)

Table 40. Shade Requirements to Achieve Load Capacity for Stream Segments. Upper Owyhee Watershed.

Stream[a]	Land Use	June Load Allocations SS[b] Criteria Of 9°C MDAT[c] Percent Shade	July Load Allocations CWAL[d] Criteria of 22°C MDT[e] Percent Shade	August Load Allocations CWAL Criteria of 22°C MDT Percent Shade	Method of Estimate[f]
Upper Deep Creek	Rangeland	100	52	59	SSTEMP
Middle Deep Creek	Rangeland	100	57	57	SSTEMP
Lower Deep Creek	Rangeland	100	66	67	SSTEMP
Deep Creek below Nickel Creek to Pole Creek	Rangeland	100	58	57	SSTEMP
Upper Pole Creek	Rangeland	96	96	58	SSTEMP
Lower Pole Creek	Rangeland	100	65	60	SSTEMP
Castle Creek	Rangeland	95	95	58	SSTEMP
Red Canyon Creek	Rangeland	94	94	57	SSTEMP
Nickel Creek	Rangeland	88	88	56	SSTEMP
Hurry Back Creek	Rangeland	92	95	54	SSTEMP
Nip & Tuck Creek	Rangeland	87	87	54	SSTEMP
Current Creek	Rangeland	91	91	53	SSTEMP
Camas Creek	Rangeland	98	98	61	SSTEMP
Camel Creek	Rangeland	97	97	62	SSTEMP
Bull Gulch	Rangeland	98	98	62	SSTEMP
Beaver Creek	Rangeland	97	97	59	SSTEMP
Upper Dickshooter Creek	Rangeland	100	100	62	SSTEMP
Lower Dickshooter Creek	Rangeland	94	65	67	SSTEMP

a. Bold = 1998 ä303(d) Listed Segments, b. salmonid spawning, c. maximum daily average temperature, d. cold water aquatic life, e.maximum daily temperature

f. .Stream Segment Temperature Model (Bartholow 1999)

Sediment Load Allocations and Targets

For sediment, the entire load allocation is assigned to the current primary land use, rangeland. Tables 41 and 42 show the load allocation calculations in tons/year for the sediment portion of the TMDL. Table 43 shows the turbidity targets to achieve load allocation for the reservoirs. Tables 44 shows the required percent fines targets to achieve load allocation. Table 45 shows the required streambank erosion rate targets to achieve the load allocation.

Table 41. Sediment Load Allocation for a target of 50 mg/l. Upper Owyhee Watershed.

Stream	Land Use	Load Capacity tons/year	MOS[a] tons/year	Load Allocation tons/year
Deep Creek	Rangeland	2,555	255.5	2299.5
Castle Creek	Rangeland	579	57.9	521.1
Nickel Creek	Rangeland	19	1.9	17.1
Upper Blue Creek Basin	Rangeland	331	33.1	297.9
Upper Juniper Basin	Rangeland	96	9.6	86.4

a. Margin of Safety

Table 42. Sediment Load Allocation for a target of 80 mg/l. Upper Owyhee Watershed.

Stream	Land Use	Load Capacity tons/year	MOS[a] tons/year	Load Allocation tons/year
Deep Creek	Rangeland	4088	408.8	3679.2
Castle Creek	Rangeland	927	92.7	834.3
Nickel Creek	Rangeland	31	3.1	27.9
Upper Blue Creek Basin	Rangeland	530	53.0	477.0
Upper Juniper Basin	Rangeland	154	15.4	138.6

a. Margin of Safety

Table 43. Turbidity Load Allocations at 25 NTUs. Upper Owyhee Watershed.

Stream	Land Use	Load Capacity (NTUs)[a]	MOS[b] (NTUs)	Load Allocation (NTUs)
Blue Creek Reservoir	Rangeland	25	2.5	22.5
Juniper Basin Reservoir	Rangeland	25	2.5	22.5

a. Nephelometric Turbidity Unit, b. Margin of Safety

Table 44. Percent Fine Allocations. Upper Owyhee Watershed.

Stream	Land Use	Load Capacity 30%[a]	MOS[b] at 30% Load Capacity	Load Allocation
Deep Creek	Rangeland	30%	3%	27%
Nickel Creek	Rangeland	30%	3%	27%
Castle Creek	Rangeland	30%	3%	27%

a. >6 mm b. Margin of Safety

Table 45. Streambank Erosion Rates. Upper Owyhee Watershed.

Stream	Land Use	Load Capacity tons/mile/year	MOS[b] tons/mile/year	Load Allocation tons/mile/year
Deep Creek	Rangeland	9.7	1.0	8.7
Castle Creek	Rangeland	48.3	4.8	43.5
Nickel Creek	Rangeland	10.6	1.0	9.6
Upper Blue Creek Basin	Rangeland	8.8	0.9	7.9
Upper Juniper Basin	Rangeland	3.8	0.4	3.4

a. Margin of Safety

5.5 Conclusion

The above tables describe the required load allocation to address both temperature and sediment issues in the Upper Owyhee Watershed. All allocations are gross estimates with the belief that once more data is collected by the appropriate land management agencies, and other interested parties, refinements to these allocations can be made.

Literature Cited

33 USC § 1251-1387. Federal water pollution control act (Clean Water Act).

40 CFR 130. Water quality planning and management.

Adams, M.H., 1986. Sagebrush post offices: A history of the Owyhee Country. Idaho State University Press. Pocatello, Idaho

Allen, D.B., Flattter, B.J., Fite, K. 1993. Redband Trout Population and Habitat Inventory in Owyhee County, Idaho. BLM Challenge Cost Share Project ID013-435001-25-9Z. Idaho Department of Fish and Game, Boise, Idaho.

Allen, D.B., Flattter, B.J., Fite, K. 1995. Redband Trout Population and Habitat Surveys in Jump, Reynolds, and Sheep Creeks, and Sections of the Owyhee County, Idaho. BLM Technical Bulletin No. 95-6. Idaho Department of Fish and Game, Boise, Idaho.

Allen, D.B.,Flattter, B.J., Fite, K. 1996. Redband Trout Population and Habitat Surveys in Southern Owyhee County, Idaho. Idaho Department of Fish and Game, Boise, Idaho.

Allen, D.B., Fite, K., Nelson, J., Flatter, B.J. 1997. Redband Trout Population and Stream Habitat Surveys in Western Owyhee County, Idaho. Idaho Department of Fish and Game, Boise, Idaho.

Allen, D.B., B.J. Flatter, J. Nelson, C. Medrow; 1998. Redband trout, Oncorhynchus mykiss gairdneri, population and stream habitat surveys in Northern Owyhee County and the Owyhee River and it's tributaries, 1997. Idaho Department of Fish and Game, Nampa, Idaho.

American Geologic Institute. 1962. Dictionary of geologic terms. Doubleday and Company: Garden City, NY. 545 pp.

Armantrout, N. B. (compiler). 1998. Glossary of aquatic habitat inventory terminology. American Fisheries Society: Bethesda, MD. 136 pp.

Bahls, L.L. 2001a. Biological intergty of streams in Southwest Idaho in 2000 based on compistation of community structure of the benthic algae community. Prepared for State of Idaho Department of Environmental Quality. Idaho Department of Envirnmental Quality. Boise, Idaho.

Bahls, L.L. 2001b. Biological intergty of streams in Southwest Idaho in 2001 based on compistation of community structure of the benthic algae community. Prepared for State of Idaho Department of Environmental Quality. Idaho Department of Envirnmental Quality. Boise, Idaho.

Bartholow, J.M. 1999. SSTEMP for Windows: The Stream Segment Temperature Model (Version 1.1.3). US Geological Survey computer model and help file http://www.mesc.usgs.gov/rsm/rsm_download.html#TEMP

Bash, J., C. Berman and S. Bolton 2001. Effects of turbidity and suspended sediment on salmonids. Center for Streamside Studies, University of Washington.

Batt, P. E. 1996. Governor Philip E. Batt's Idaho bull trout conservation plan. State of Idaho, Office of the Governor: Boise, ID. 20 pp + appendices.

Bedell, T.E., Eddleman, L.E., Deboot, T., Jacks, C. 1991. Western Juniper-Its impact and management in Oregon rangelands. Watershed Management Guide for Interior Northwest. EM 8436. Oregon State University Extension Service, Administrative Services A422, Corvallis, Oregon.

Brown, G.W., 1969. Predicting temperatures on small streams. Water Resources Research 5(1): 68-75.

Brown, G.W.,1970. Predicting the effects of clearcutting on stream temperature. Journal Soil and Water Conservation. 25:11-13.

Burton, T.A. 1991. Protocols for evaluation and monitoring of stream/riparian habitats accosiated with aquatic communitees in rangeland streams. Water Quality Monitoring Protocol No. 4. Idaho Department of Environmental Quality. Boise, Idaho.

Clark W.H., 1978. Owyhee River, Owyhee County, Idaho. Water Quality Status Report. Idaho Department of Envirnmental Quality. Boise, Idaho.

Clark, W.H., 1979. Burneau River, Owyhee County, Idaho. Water Quality Status Report. Idaho Department of Envirnmental Quality. Boise, Idaho.

Clark, W.H., 2002. Upper Owyhee TMDL, Subbasin Assessment-Macroinvertebrate Biotic Integrity report. Idaho Department of Environmental Quality. Boise, Idaho

Climatic Service Center, 2001. Hollister, Idaho meda file. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?idholl

Cowley, E. R.1993. Protocols for monitoring vegetation utilization for riparian communitees associated with rangeland streams. Water Quality Monitoring Protocol No. 8. Idaho Department of Environmental Quality. Boise, Idaho.

Dupont, J., 1999. Memorandum; fish and habitat evaluation in tributaries of South Mountain. *in* North and Middle Fork Owyhee Subbasin Assessment and Total Maximum Daily Load. Idaho Department of Environmental Quality. Boise, Idaho.

Dupont, J., 1999. Memorandum: stream temperature in Pleasant Valley and Wickiup Creeks. Idaho Department of Lands, Coeur d' Alene, Idaho.

EPA. 1996. Biological criteria: technical guidance for streams and small rivers. EPA 822-B-96-001. U.S. Environmental Protection Agency, Office of Water: Washington, DC. 162 pp.

EPA. 1997. Guidelines for preparation of the comprehensive state water quality assessments (305(b) reports) and electronic updates: supplement. EPA-841-B-97-002B. U.S. Environmental Protection Agency: Washington, DC. 105pp.

Goeldner, C.A., M. G. Sawlan, H.D. King, R.A. Winters, A.M. Leszcykowski, and D.E. Graham; 1987. Mineral Resources of the Battle Creek, Yatahoney Creek, and Juniper Creek. Wilderness Study Area, Owyhee County, Idaho. USGS Survey Bulletin #1719.USGS, Denver, Colorado.

Grafe, C. S., M. J. McIntyre, C. A. Mebane, and D. T. Mosier. 2000. The Idaho Department of Environmental Quality water body assessment guidance, second edition. Idaho Department of Environmental Quality: Boise, ID. 114 pp.

Greenborg, A. E., L. S. Clescevi, and A. D. Eaton (editors). 1992. Standard methods for the examination of water and wastewater, 18th edition. American Public Health Association: Washington, DC.

Herbert, D.W.M. and J.C. Merkens. 1961. The effects of suspended mineral solids on the survival of trout. International Journal of Air and Water Pollution. 5:46-55.

Horsburgh, B. 2002. DRAFT. Draft sediment analysis for the Succor Creek TMDL. Idaho Department of Environmental Quality. Boise, Idaho.

Hortness. J.E. and C. Berenbrock, 2001. Estimating monthly and annual streamflow statistics at ungaged sites in Idaho. Water-Resources Investigations Report 01-4093. United States Geological Survey and United States Department of Agriculture, Forest Service. Boise, Idaho.

Hughes, R. M. 1995. Defining acceptable biological status by comparing with reference condition. *In* Davis, W.S. and T.P. Simon (editors). Biological assessment and criteria: tools for water resource planning. CRC Press: Boca Raton, FL. 31-48 pp.

Idaho Code § 39.3611. Development and implementation of total maximum daily load or equivalent processes.

Idaho Code § 3615. Creation of watershed advisory groups.

Idaho Department of Agriculture-Soil Conservation Commission, 1993. Idaho Agricultural Pollution Abatement Plan. Idaho Soil Conservation Commision. Boise, Idaho

Idaho Department of Commerce. 2001. Internet Retrieval, Statistical analysis of Idaho counties. Idaho Department of Commerce. Boise, Idaho. *http:/www.idoc.state.id.us/pages/STATSPAGE.html.*

Idaho Department of Environmental Quality, 1988. Idaho water quality status report and nonpoint assessment . Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Environmental Quality, 1990. Coordinated nonpoint source monitoring program for Idaho. Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Environmental Quality, 1994. 1994 §303(d) list . Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Environmental Quality, 1997. Paradise Creek Total Maximum Daily Load. Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Environmental Quality, 1998. 1998 §303(d) list. Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Environmental Quality, 1999*a*. South Fork Owyhee River Subbasin Assessment and Total Maximum Daily Load. Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Environmental Quality, 1999*b*. Nonpoint Source Management Plan. Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Environmental Quality, 1999*c*. North and middle Fork Owyhee Subbasin Assessment and Total Maximum Daily Load. Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Environmental Quality, **DRAFT** 2000*a*. Water Body Assessment Guidance. 2nd Edition. Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Environmental Quality, **DRAFT** 2000*b*. Idaho Rivers Ecological Assessment Framework. Idaho Department of Environmental Quality. Boise, Idaho

Idaho Department of Environmental Quality, 2000*c.* Policy Statement on Use of Surrogote Measrements for Devloping TMDLs. Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Environmental Quality, 2000*d.* Bruneau River Subbasin Assessment and Total Maximum Daily Load. Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Environmental Quality, Personal Communication Essig, 2001. Critical Period Temperature Load Analysis. Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Environmental Quality, 2002. Water Body Assessment Guidance. 2nd Edition. Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Fish and Game, Personal Communication, Scott Grunder, 2001a. Boise, Idaho.

Idaho Department of Fish and Gam, 2001b. Fisheries Management Plan, 2001-2006. Idaho Department of Fish and Game. Boise, Idaho.

Idaho Department of Fish and Game, 2001C Internet retrieval, ww2.state.id.us/fis…sh /fishstocking/history/CountySearch.cfm

Idaho Department of Water Resources, 1971. Inventory of dams in the State of Idaho. Idaho Department of Water Resources. Boise, Idaho.

IDAPA 58.01.02. Idaho water quality standards and wastewater treatment requirements.

Ingham, M. J., 2000. Upper Owyhee Watershed Monitoring Plan. Idaho Department of Environmental Quality. Boise, Idaho.

Ingham, M.J. 2001. Personal observation of streams in Owyhee County. Idaho Department of Environmental Quality. Boise, Idaho.

Karr, J. R. 1991. Biological integrity: a long-neglected aspect of water resource management. Ecological Applications. 1:66-84.

Larson, L.L., Larson, S. 1996. Riparian Shade and Stream Temperature: A Perspective. Rangelands 18(4)

Lloyd, D.S., 1987. Turbidity as a water quality standard for salmonid habitats in Alaska. North American Journal of Fisheries Management 7:18-33

Minor, S.A., H.D. King, D.M Kulik, D.L. Sawatzky and D.O. Capstick, 1987. Mineral Resources of the Upper Deep Creek Wilderness Study Area, Owyhee County, Idaho. USGS Survey Bulletin #1719.USGS, Denver, Colorado.

Mosely, C.M., P.S. Cook, A.J. Griffs and J.O. Laughlin, 1997. Guidelines for managing cattle grazing in riparian ares to protect water quality: Review of research of best management pratices policy. Idaho Forest, Wildlife and Range Policy Analysis Group, University of Idaho. Report No. 15. Moscow, Idaho.

Munn, R.E., 1966. Descriptive Micrometeorology. Academic Press Inc., New York.

National Sedimentation Laboratory, 2002. Revised Universal Soil Loss Equation. United States Department of Agriculture, Agriculture Research Service. Internet Retrieval. www.sedlab.olemiss.edu/rusle/description.html and www.iwr.msu.edu/~ouyangda/rusle/k_factor.html

Natural Resource Conservation Service, 1983. Erosion and Sediment Yeild IN: Proceeding from Channel Evaluation Workshop. Ventra, California.

Nevada, Stae Environmental Commission, 1999. Adopted regulation of the state environmental commission. LCB File No. R017-99. Effective date September 27, 1999. www.leg.state.nv.us/register/99Register/R017-99Adopted.htm

Oregon Department of Environmental Quality, 2001. Umatilla River Basin Total Maximum Daily Load and Water Quality Management Plan. Oregon Department of Environmental Quality. Portland, OR. www.deq.state.or.us/wq/TMDLs/Umatilla/Umatilla

Overton, C.K., J.D. McIntyre, R. Armstrong, S.L. Whitwell, and K.A. Duncan. 1995. User's guide to fish habitat: description that represent natural conditions in Salmon River Basin, IdahoUnited States Forest Service, Intermountain Research Station. General Technical Report INT-GTR-322, Ogden, Utah.

Pierson, F.B., C.W. Slaughter and Z.K. Cram, 2001. Long term stream discharge and suspended sediment database, Reynolds Experimental Watershed, Idaho, United States. Northwest Watershed Research Center, Agriculture Research Service, United States Department of Agriculture. Water Resources Research, Vol 37, No. 11, p. 2857-2861. Boise, Idaho.

Platts, W.S. 1979. Livestock grazing and riparian/stream ecosystem-an overview. Reprinted from: Proceeding-Fourm—Grazing and riparian/stream ecosystems. P 39-45. Oliver B. Cope, ed. Trout Unlimited, Inc. 1979. Forest Service, United States Department of Agriculture. Intermountain Forest and Range Experiment Station. Boise, Idaho

Platts, W.S. and R.L. Nelson, 1985. Streamside and upland vegetation use by cattle. Rangelands 7:5-7.

Platts W.S. and M. Onishuk, 1988. "Good" Beavers-"Bad" Beavers. Idaho Wildlife. United States Forest Service, United States Department of Agriculture. Intermountain Research Station. Boise, Idaho. P 22-26.

Plew, M. G., 1985. A prehistoric settlement pattern for the Southcentral Owyhee Uplands, Idaho. Dissertation, Department of Anthropology, Indiana University, Bloomington, Indiana.

Public Law 92-50. Federal water pollution control act (Clean Water Act).

Public Law 100-4. Water quality act of 1987.

Poole, G.C and C.H. Berman, 2000. Pathways of human influences on water temperature dynamics in stream channels. United States Environmental Protection Agency. Seattle, Washington.

Ralston, G., M. Browne. 1976. Technical procedures manual for water quality monitoring. Idaho Department of Health and Welfare, Division of Environmental Quality. Boise, Idaho.

Rand, G. W. (editor). 1995. Fundamentals of aquatic toxicology: effects, environmental fate, and risk assessment, second edition. Taylor and Francis: Washington, DC. 1125 pp.

Relyea, C.D, G.W. Minshall and R.J. Danehy. 2000. Stream insects as bio-indicators of fine sediment. In: Proceeding Watershed 2000, Water Federation Specialty Conference, Vancouver, B.C.

Robinson, C.T. and G.W. Minshall. 1994. Biological metrics for regional biomonitoring and assessment of small streams in Idaho. Stream Ecology Center, Department of Biological Sciences, Idaho State University, Pocatello, Idaho.

Rosgen, D.L. 1996. Applied river morphology. Western Hydrology. Lakewood, Colorado.

Sigler, J.W., T.C. Bjorn, F.H. Forest. 1984 Effects of chronic turbidity on density and growth of Steelhead and Coho Salmon. Transcription of the American Fisheries Society. Vol. 113:142-150.

Simpson, J., and R. Wallace. 1982. Fishes of Idaho. University of Idaho Press. Moscow, Idaho.

Stanford, J.A., J.V. Ward, and B.K. Ellis, 1994. Ecology of the alluvial aquifer of the Flathead River, Montana. I*n* J. Gilbert, D.L. Danielopol and J.A. Stanford (eds) Ground water Ecology, Academic Press, San Diego, California

Strahler, A. N. 1957. Quantitative analysis of watershed geomorphology. American Geophysical Union Transactions. 38:913-920.

Strand, M. and R.W. Merritt, 1999. Impacts of livestock grazing activities on stream insect communities and the riverine environment. American Entomologist, Volume 45: No. 1.

Strong, J. C. 2000. Analysis or a regional application of Idaho water quality standards temperature exemption. Idaho Department of Environmental Quality. Boise, Idaho.

Swalan, M.G.,, H.D. King, D.M Kulik, J. D. Hoffman, D.O. Capstick, P.N. Gabby, A.R. Buehler 1987. Mineral Resources of the Owyhee River Canyon and Deep Creek- Owyhee River Wilderness Study Area, Owyhee County, Idaho. USGS Survey Bulletin #1719.USGS, Dnver, Colorado,

Thomas, C. W., J.W. Harvey, O.L. Franke, W.A. Alley 1998. Ground water and surface water, a single resorce. United States Geological Survey, Circular 1139. Denver, Colorado.

Teti, P., 1998. The effects of forest practices on stream temperature; A review of the literature. British Columbia Ministry of Forests. Williams Lake, B.C. Canada.

United States Department of Interior-Bureau of Land Management, 1999. Owyhee Resource Area Management Plan and Final Environmental Impact Statement. Volumes 1-3. USDI-Bureau of Land Management, Lower Snake District, Boise Field Office. Boise, Idaho.

United States Department of Agriculture-Natural Resource Conservation Service 2001Department of Agriculture-Natural Resource Conservation Service, 2001. Internet Retrieval Sno-Tel http://idsnow.id.nrcs.usda.gov/snow/snotel.htm

United States Environmental Protection Agency, 1972. Water quality criteria 1972 (Blue Book). United States Environmental Protection Agency. Washington D.C.

United States Geological Survey. 1987. Hydrologic unit maps. United States Geological Survey water-supply paper 2294. U.S. Geological Survey: Denver, CO. 63 pp.

United States Geological Survey, Surface Water Data for Idaho, 2001. http://water.usgs.gov/id/nwis/sw

United States Department of Agriculture-Natural Resource Conservation Service, 2001. http://www.nass.usda.gov/census/census97/volume1/id-12/toc97.htm

United States Geological Survey 7.5 minute quad map, Hurry Back.

Washinghton State Department of Ecology, 1999. The Simpson Northwest Timberlands temperature total maximum daily load submittal. Wasgington State Department of Ecology. Olympia, Washington.

Water Pollution Control Federation. 1987. The Clean Water Act of 1987. Alexandria VA. 318 pp.

Waters, T.F. 1995. Sediment in streams: source, biological effects and control. American Fisheries Society, Monograph 7. Bethesda, Maryland.

Western Regional Climate Center, Internet Retrieval 1999.

Wroblicky, G.L., M.E. Campana, H.L. Valett, J.A. Morrice, K.S. Henery, and M.A. Baker 1996. Seasonl variation in surface-subsurface water exchange and laterial hyporheic area of two stream-aquifer systems. Water Resource Research. 34:317-328.

Zaroban, D.W. 2000. Protocol for placement and retrievel of temperature data loggers in Idaho streams. Water Quality Protocols-Report No. 10. Idaho Department of Environmental Quality. Boise, Idaho

Zoellick, B.W. 1999. Stream temperatures and elevational distribution of redband trout in Southwest Idaho. Great Basin Naturalist, vol. 59, no 2.

Zoellick, B.W., 2001. Personal Communication. Unites Bureau of Land Management, United States Department of the Interior. Boise, Idaho.

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